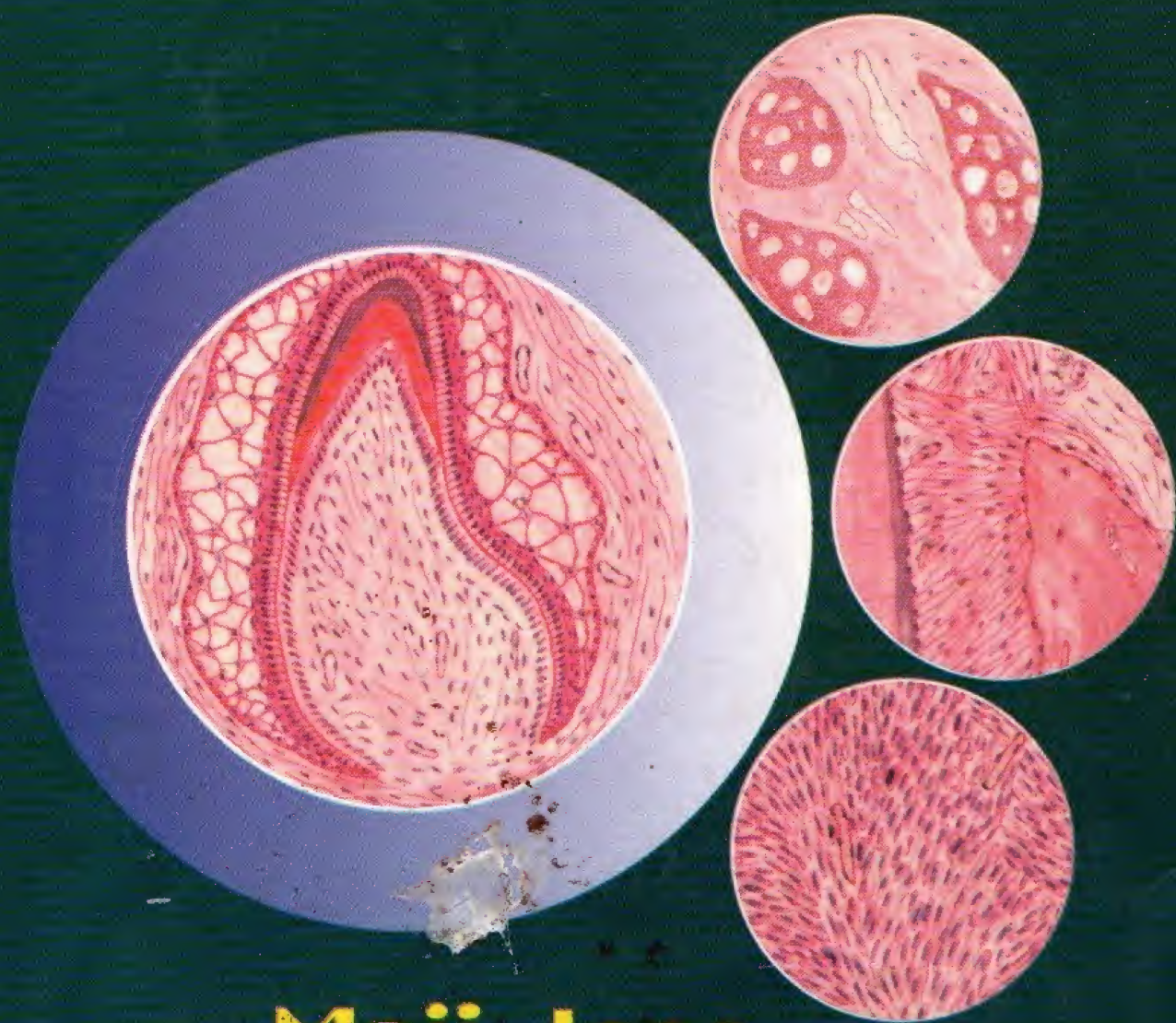


Manual of
ORAL HISTOLOGY
&
ORAL PATHOLOGY
Colour Atlas and Text



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Section 1

Oral Histology

- PREPARATION OF ORAL TISSUES FOR MICROSCOPIC EXAMINATION
- CELLS AND TISSUES
- DEVELOPMENT OF TEETH
- ENAMEL
- DENTIN
- PULP
- CEMENTUM
- PERIODONTAL LIGAMENT
- MAXILLARY SINUS
- ORAL MUCOSA
- SALIVARY GLAND

1

Preparation of Oral Tissues for Microscopic Examination

- Study of dental hard tissues
 - Ground sections
 - Decalcified sections
- Study of oral soft tissues
 - Routine tissue processing

A sound knowledge of the structures of oral tissue is very much essential for understanding of this region. The knowledge about these structures gives the clinician an insight into the understanding of the disease mechanism that may develop in these tissues and predict the reaction of tissues to various factors etc.

Microscopic examination is the method adopted to study the histological structures of the oral tissues. To study the histological structure, the tissue should be appropriately prepared for microscopic examination.

STUDY OF DENTAL HARD TISSUES

The structure of dental hard tissues can be studied using ground sections or decalcified sections. (The exception is enamel, where decalcified sections are not of much use because 96% of enamel is mineralized, which is lost while decalcification.)

Decalcification

Decalcification is the process by which calcium in the mineralized tissue is removed so that the tissue becomes soft enough to make sections. Decalcification is achieved by using acids, chelating agents or by electrolysis. The commonly used method is acid decalcification.

Frequently used acid for decalcification is 5% Nitric acid. 15% Formic acid may also be used. Nitric acid may cause yellowing of the tissue, that may interfere with further staining procedure. To avoid this 0.1% urea is added to nitric acid.

Procedure

Hard tissue to be decalcified should be fixed in 10% formalin or formal saline. To reduce the time for decalcification tissue may be cut into smaller pieces. Then place the tissue in a container with 5% nitric acid. The acid should be changed daily for few days. The specimen is then tested for completion of decalcification.

Methods to check the completion of decalcification

1. **Checking the consistency of the tissue:** Completely decalcified tissue will be soft without any hardness being felt.

(Experienced hand can tell by the feel of the tissue.)

2. **Piercing the tissue with a needle:** If it enters the tissue without resistance, the tissue is completely decalcified. This is not recommended because it may cause damage to the tissue.
3. **Judicious bending or trimming of the tissue:** This can be done to ensure completion of decalcification.
4. **Taking radiograph of the specimen:** In the radiograph, if radiopaque specks are found, tissue is not completely decalcified.
5. **Chemical test:** The basis of this test is to identify calcium in the decalcifying solution in which the specimen was kept. Sodium hydroxide or strong ammonia is added to 5 ml of decalcifying fluid, to neutralize the solution. Then 5ml of saturated ammonium oxalate solution is added. After this, check for turbidity. Absence of turbidity after 5 minutes indicate the fluid is free from calcium and thereby decalcification is complete. Turbidity is observed due to precipitation of calcium. If precipitation is observed after addition of sodium hydroxide, it indicates large amount of calcium is present in fluid. Precipitation seen only after addition of ammonium oxalate suggests decalcification is nearly complete.

Checking the end point of decalcification is important because incomplete decalcification makes further cutting of specimens difficult. Prolonged decalcification is also not desirable because it may affect the staining procedure. Once the decalcification is complete the tissue should be washed in running water to remove all acids. Then the steps of processing can be continued like soft tissue processing which includes dehydration, embedding, sectioning and staining.

Ground Sections

Ground sections are of particular importance in the study of structure of dental hard tissues especially enamel. In this method the tooth is made into thin sections by grinding, using abrasive stones.

Procedure

The tooth to be examined should be cut into 2-3 sections using dental hand piece and diamond impregnated or carborundum disc. These sections should be ground using an Arkansas stone or by simply rubbing on a glass plate using abrasive slurry. Grinding should be continued till it is approximately 25-50 microns thick. Fine abrasives should be used for the final polishing. Most suitable abrasive is domestic scouring powders followed by soapy water. Once the desirable thickness is attained the section should be washed and dehydrated and mounted on a glass slide using synthetic resin or Canada balsam as mounting medium and is allowed to dry.

Grinding of the tooth can also be done using a laboratory lathe. Initial grinding is done by holding the tooth in fingers and pressing it against the rotating coarse abrasive wheel of a lathe. When the tooth is thin, it is difficult to hold with fingers. Therefore a wooden block wrapped with adhesive plaster with sticky side directed outward can be used. Stick the tooth on to the plaster and press the wooden block to the rotating wheel of the lathe so that the tooth is ground thin. Then change the coarse wheel to fine wheel and continue grinding till the section is sufficiently thin. To remove the adhesive plaster the sections can be soaked in water. The section removed from the plaster is then mounted on a glass slide using a mounting medium.

Precision equipments like hard tissue microtomes are now available for the preparation of ground sections.

STUDY OF ORAL SOFT TISSUES

The most commonly used method of preparing soft tissue for the light microscopic study is by embedding the tissue in paraffin, and cutting and mounting the section on slides and staining.

Preparation of sections of Paraffin embedded specimens (Soft tissue processing)

1. **Obtaining the specimen:** Specimens for microscopic study are obtained through either biopsy or autopsy.

Biopsy is the removal of tissue from a living organism for the purpose of microscopic examination and diagnosis. If tissue is taken for the same purpose from dead organisms it is called autopsy.

2. **Fixation:** After the removal, specimen should be kept in fixative solution at the earliest. The amount of fixative should be approximately 25 times the size of the specimen. Depending on the size and density of the specimen the fixation time can vary from few hours to days. Usually 24 hrs. is sufficient for small specimens.

Commonly used fixative is 10% buffered formalin. Other fixatives used are methyl alcohol, ethyl alcohol etc.

The aims of fixation are -

- To preserve the cells & tissue constituents in life like condition as closely as possible without loss or derangement.
- To prevent the process of autolysis and bacterial action or putrefaction of tissues.
- To coagulate the proteins, thus reducing the change in shape or volume during further processing of tissue and to make the tissue more readily permeable to the subsequent application of reagents.

After fixation the specimen is washed in running water.

3. **Dehydration of specimen:** Dehydration is the process by which the water content from the tissue specimen is removed to allow the penetration of paraffin. Dehydrating agents commonly used are alcohol and acetone. Gradual dehydration is done using increasing grades of alcohol (40, 60, 80 & 95% and absolute alcohol). To ensure complete removal of water, the specimen is placed in 2-3 changes of absolute alcohol. After dehydration the water in the specimen is completely replaced by alcohol.
4. **Clearing:** Alcohol is not miscible with paraffin. So impregnation of the tissue by paraffin is not possible unless alcohol is replaced by a fluid that is miscible with both alcohol and paraffin. The fluid used for this purpose is xylene. Xylene is an organic solvent, miscible with alcohol and paraffin. This process is called clearing because tissue becomes transparent or clear after the treatment with xylene. This occurs because the refractive index of xylene is similar to that of proteins in the specimen. Other clearing agents used are toluene, chloroform, benzene, etc.
5. **Impregnation of specimen with paraffin:** After clearing the specimen should be transferred to a dish with molten wax and this should be kept in an oven where temperature is adjusted to around 60° C. The xylene in the specimen is gradually replaced by paraffin. To ensure complete impregnation 2-3 changes of molten paraffin is required.
6. **Embedding:** The specimen is embedded in paraffin after impregnation. For this a paper box or Leuckhart's 'L' pieces fixed to form a cube can be used. Fill the cube

with molten wax and the specimen can be embedded in to this with the help of a warm forceps. Allow the wax to cool and solidify. When the 'L' forms are removed the tissue is found embedded in a cube of solidified wax block.

7. **Cutting the specimen:** The tissue specimen embedded in the paraffin wax is clamped to a rotary microtome to take sections of desirable thickness of 4-10 microns.
8. **Mounting the cut sections on microscopic glass slides:** Sections taken using a microtome is floated on warm water

and mounted on to a microscopic slide coated with adhesive. The slide is then placed on a slide warmer adjusted to a temperature of 40° C which helps to adhere the sections to the slide.

9. **Staining the section:** The sections are now ready for staining. Routinely used stain is hematoxylin and eosin. After staining mounting is done using a mounting medium. Commonly used mounting medium is Distrene dibutyl phthalate xylene (DPX) . After mounting it is allowed to dry, before microscopic examination.

Cells and Tissues

- Epithelial tissue
 - Stratified squamous epithelium
 - Pseudostratified ciliated columnar epithelium
- Connective tissue
 - Fibroblasts and fibrocytes
 - Fat cells
 - Bone cells
 - Cartilage cells
 - Endothelial cells
 - Muscle
 - Defence cells
 - Giant cells
- Cells of odontogenic apparatus

Cells are the basic structural units of the body. A group of cells performing the same function forms a tissue. Two important basic tissues of the body are epithelium and connective tissue.

EPITHELIAL TISSUE

Epithelium is an ectoderm derived tissue that forms a protective covering of connective tissue. Although there are different types of epithelia in the human body, the main types important for students of dentistry are stratified squamous

epithelium that forms the lining of oral cavity and pseudo stratified ciliated columnar epithelium lining the maxillary sinus and respiratory tract.

Stratified Squamous epithelium (Fig. 2.1)

In stratified squamous epithelium the cells are arranged in different layers or strata. The basal cells are cuboidal in shape with central nucleus, arranged in single layer on the basement membrane. The superficial cells are squamous or polyhedral in outline with centrally placed nucleus. All these cells are attached to each other by desmosomal junctions.

Pseudo stratified ciliated columnar epithelium (Fig. 2.2)

The cells of the ciliated columnar epithelium are columnar in shape, of varying sizes arranged in a single layer on a basement membrane. The nuclei of the cells are placed at different levels giving the erroneous appearance of stratification. The cells on the superficial aspect have cilia which help in the movement of the mucous secretions. Among the columnar cells unicellular secretory organs called goblet cells are also noticed. Goblet cells are goblet shaped with a basally placed nucleus and apical cytoplasm filled with secretory products.

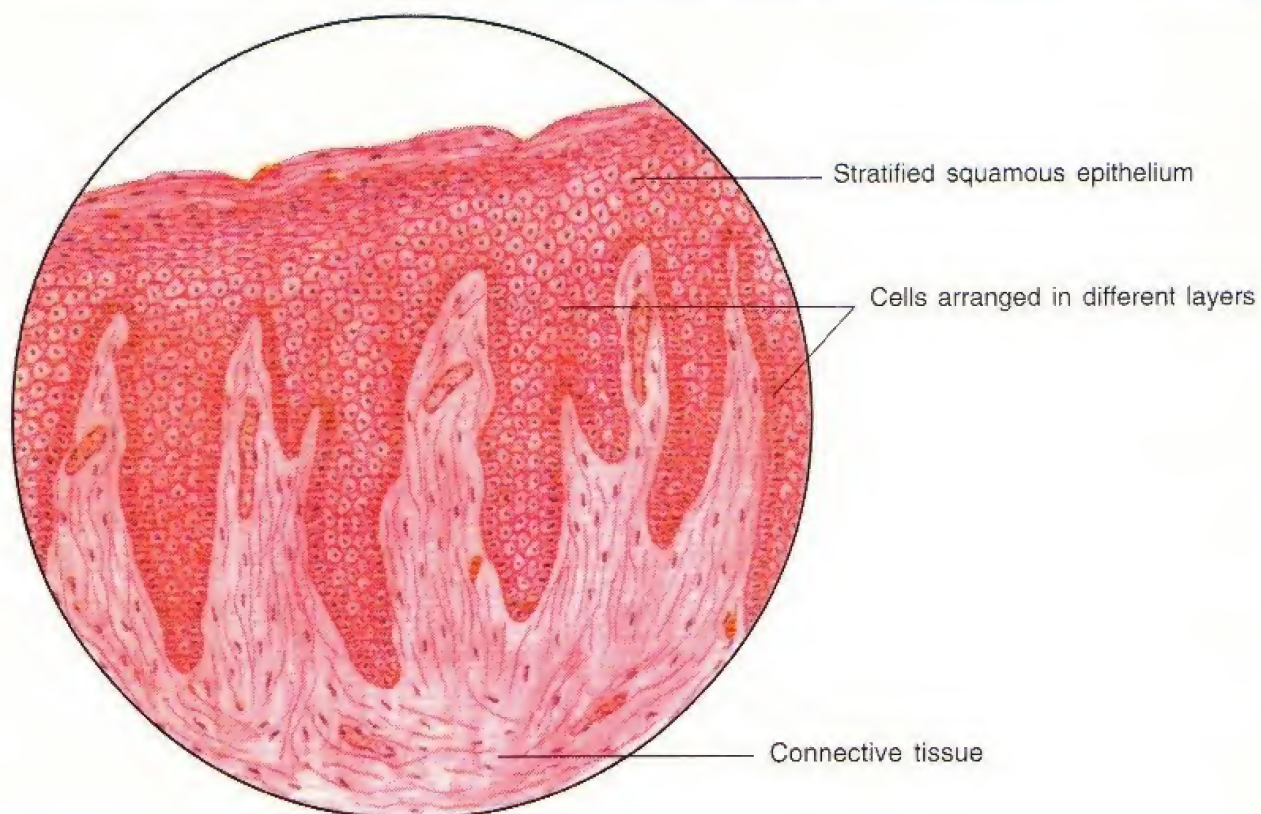


Fig. 2.1 Stratified squamous epithelium

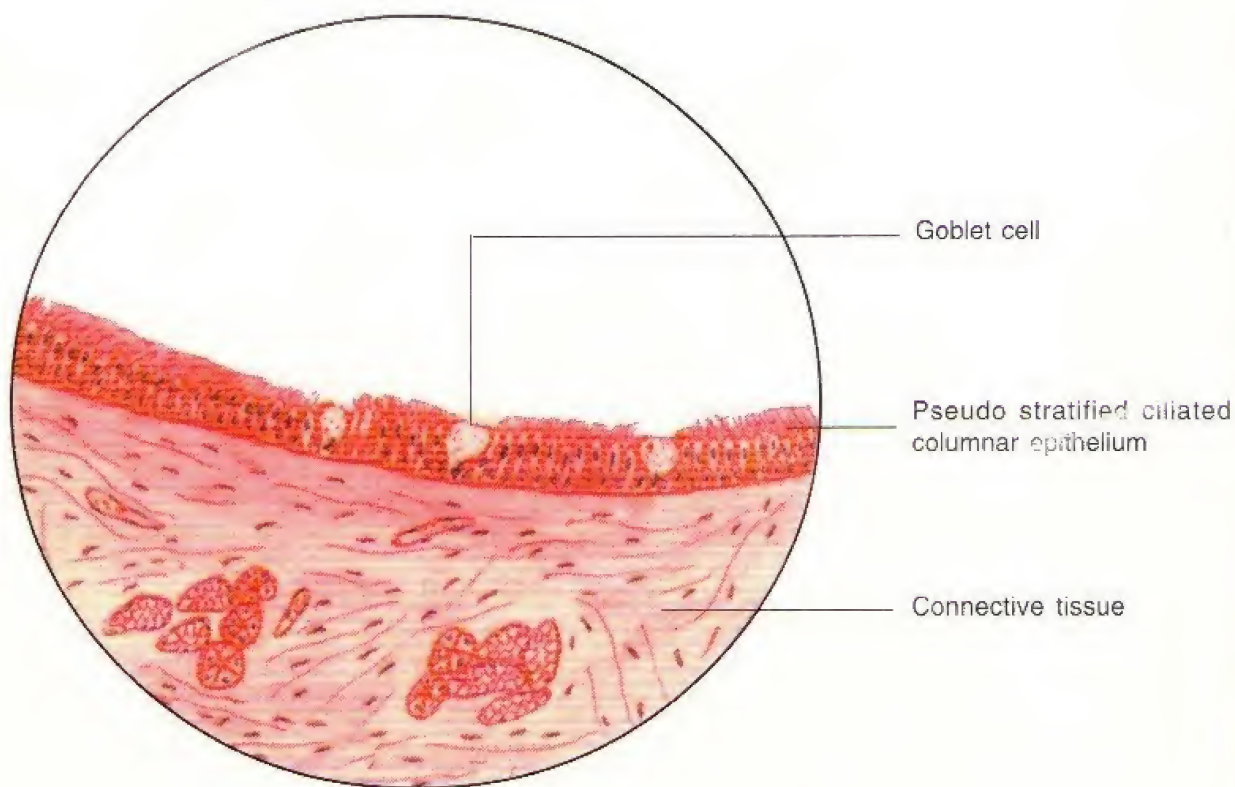


Fig. 2.2 Pseudo stratified ciliated columnar epithelium

CONNECTIVE TISSUE

Connective tissue is of mesodermal origin and comprises of fibers, ground substance and cells. The primary groups of fibers are collagen fibers. Collagen fibers are arranged to form bundles and stain pink in H and E stained sections. Collagen fibers and cells are embedded in ground substance, rich in proteoglycans and glycoproteins. Fibers and ground substance together constitute the extra cellular component. Cellular components are :-

Fibroblasts and fibrocytes (Fig. 2.3)

These are the primary cells of the connective tissue. **Fibroblasts** are ovoid or star shaped cells with multiple cytoplasmic processes. The cell has large, round and vesicular or open face nucleus and abundant cytoplasm exhibiting slight

basophilia indicating that they are highly active in protein synthesis. **Fibrocytes** are spindle shaped with flat deeply staining, close face nucleus. Fibroblast and fibrocytes are arranged parallel to the collagen fibers.

Fibroblasts are the synthetic cells that produce collagen fibers and ground substances. They also help to degrade these components, thereby helping in remodelling of connective tissue. Fibrocytes are resting cells in connective tissue.

Fat cells or adipocytes (Fig. 2.4)

These are the cells those synthesize and store fat. These cells are spherical or ovoid with a flattened nucleus displaced to the periphery. These cells filled with fat are usually seen as groups where they are compressed with each other giving rise to polyhedral shape. In routine H and E stained histological sections fat cells

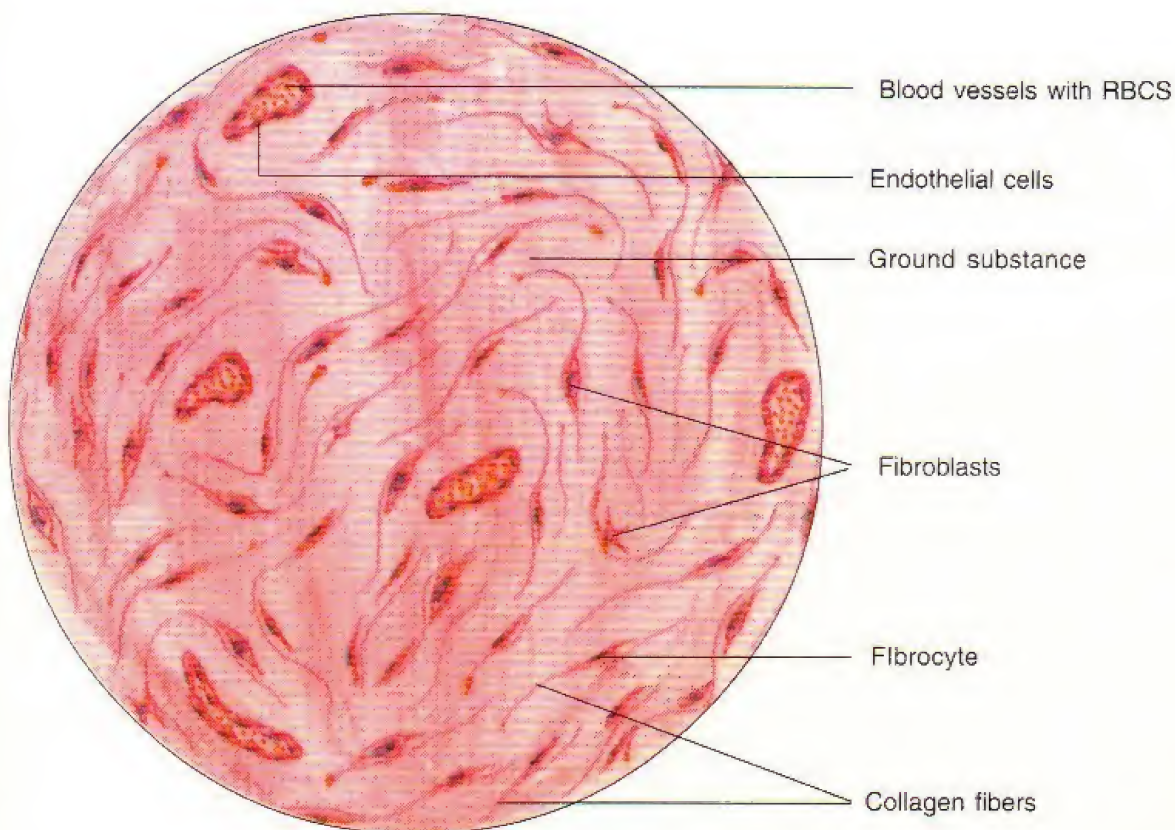


Fig. 2.3 Fibroblasts, Fibrocytes & Endothelial cells

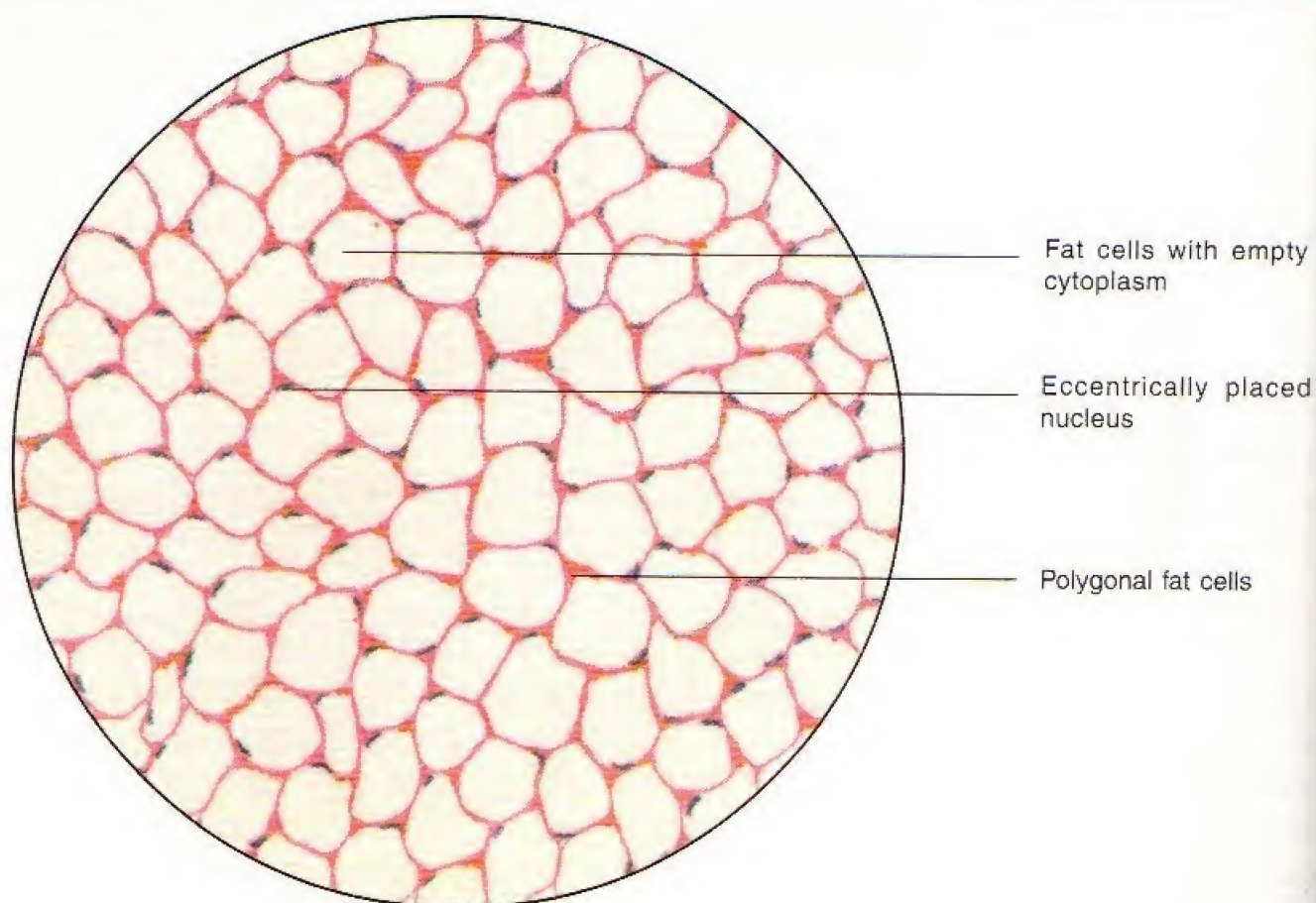


Fig. 2.4 Fat cells

appear as empty cells because fat is dissolved during processing. Fat cells can be stained by a special stain called Sudan III. Fat cells are distributed in the sub mucosal tissue.

Osteoblasts, Osteocytes and Osteoclasts (Fig. 2.5)

Osteoblasts are synthetic cells of bone that help in the formation of bone, by matrix deposition and mineralization. They are cuboidal or ovoid cells with centrally placed ovoid open face nucleus. Osteoblasts are arranged along the periphery of the bony trabeculae, forming a lining or rimming of the trabeculae.

Osteocytes are resting cells found entrapped in the bone. They occupy spaces called lacunae. Osteocytes have a cell body and processes called canaliculi. Cells are ovoid or flat with close faced nucleus and scanty

cytoplasm.

Osteoclasts are the cells which resorb the bone. Osteoclasts are derived from circulating monocytes. They are large giant cells with multiple nuclei. These cells occupy irregular resorption bays called Howship's lacunae.

Chondroblasts and chondrocytes (Fig. 2.6)

Chondroblasts are cartilage forming cells. They appear as flattened or elliptical cells and are located at the periphery of cartilage parallel to the surface.

Chondrocytes are the cells entrapped in the cartilaginous matrix. They are located in spaces called lacunae. Usually the chondrocytes are seen as groups of 2-4 cells and is described as 'cell nests'.

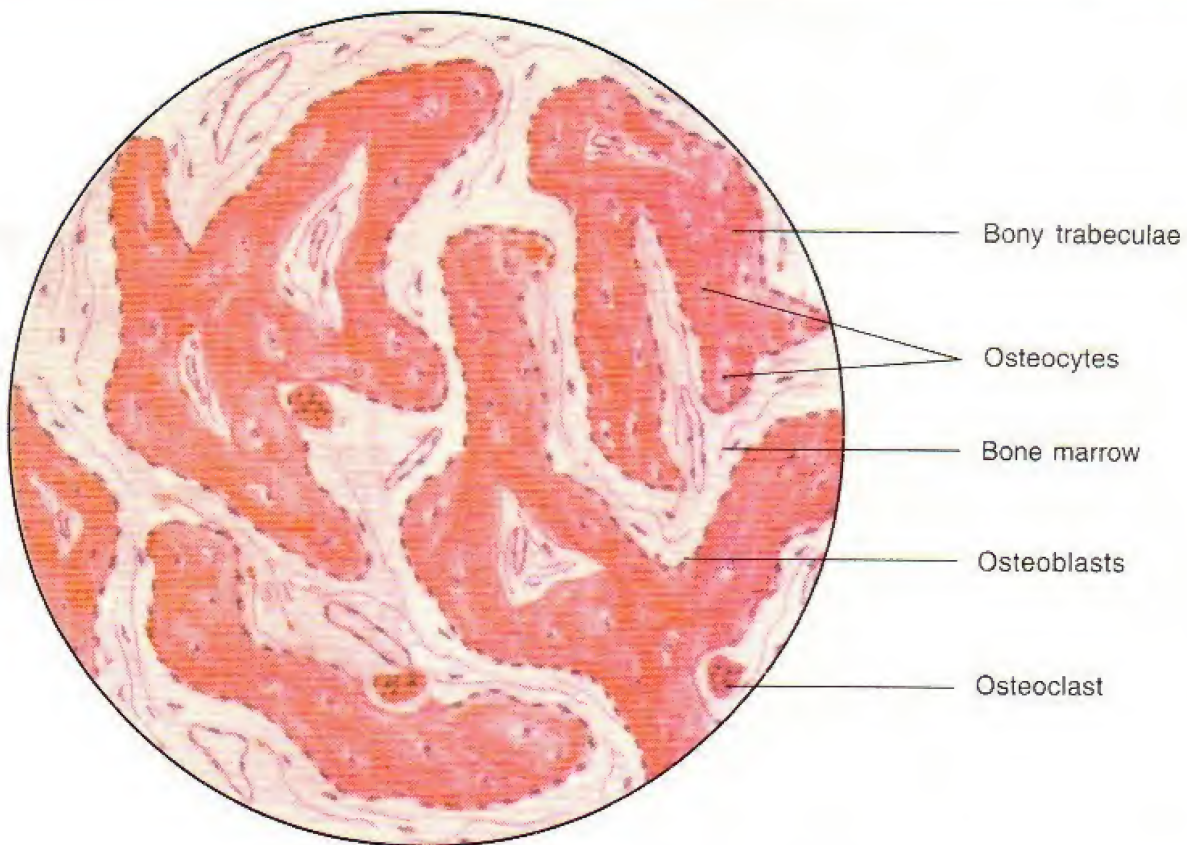


Fig. 2.5 Osteoblasts, osteocytes & osteoclasts

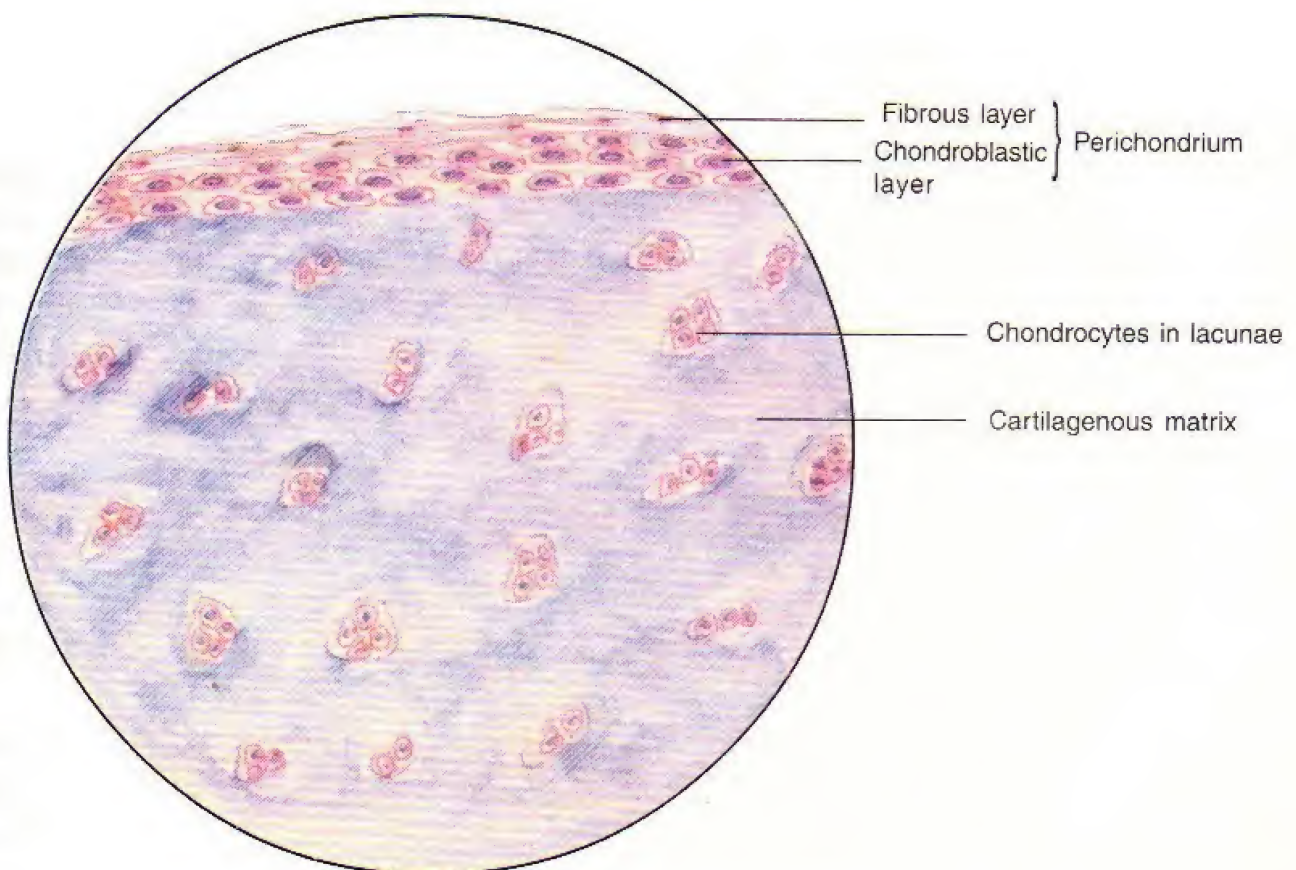


Fig. 2.6 Chondrocytes and chondroblasts

Endothelial cells (Fig. 2.3)

Endothelial cells are the cells lining the blood capillaries. They form a single layer of flattened cells having flattened nucleus resting on the basement membrane.

Striated muscle (Fig. 2.7)

Striated muscle is seen as highly eosinophilic cylinder like structures in a hematoxylin and eosin stained sections. Each muscle fiber is composed of many myofibrils. Fibers show characteristics transverse striations. The cytoplasm of muscle or sarcoplasm is rich in cytoplasmic organelles. Nuclei are flattened, multiple and are located at the periphery. The muscle as a whole is enclosed in connective tissue called epimysium. This connective tissue extends inwards dividing muscle into fasciculi. These extensions are called perimysium, from which again septa

(endomysium) extend that invests individual muscle fibers.

Neutrophils

Neutrophils are defence cells of the body functioning as first line of defence against invading microorganisms. They are active in acute infections and thereby belong to the group of acute inflammatory cells. Neutrophils are 7 to 9 microns in diameter, have three to five lobes of nuclei and cytoplasmic granules, containing various enzymes.

Plasma Cells (Fig. 2.8)

Plasma cells are derived from B-lymphocytes and are specialized for the synthesis of anti bodies (immunoglobulin) thereby imparting resistance to the body against diseases. They are ovoid in shape with basophilia of cytoplasm and eccentric, oval

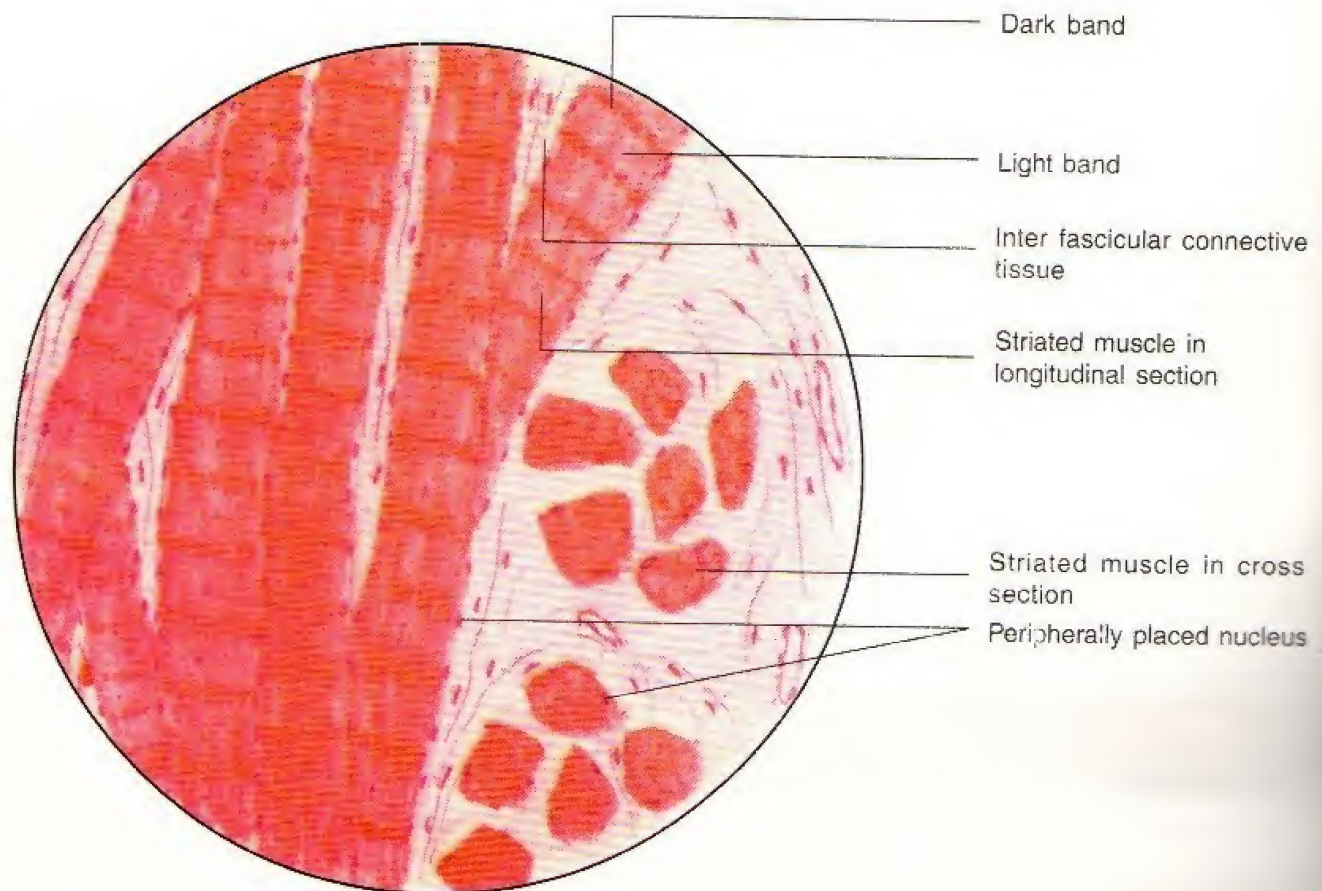


Fig. 2.7 Striated muscle

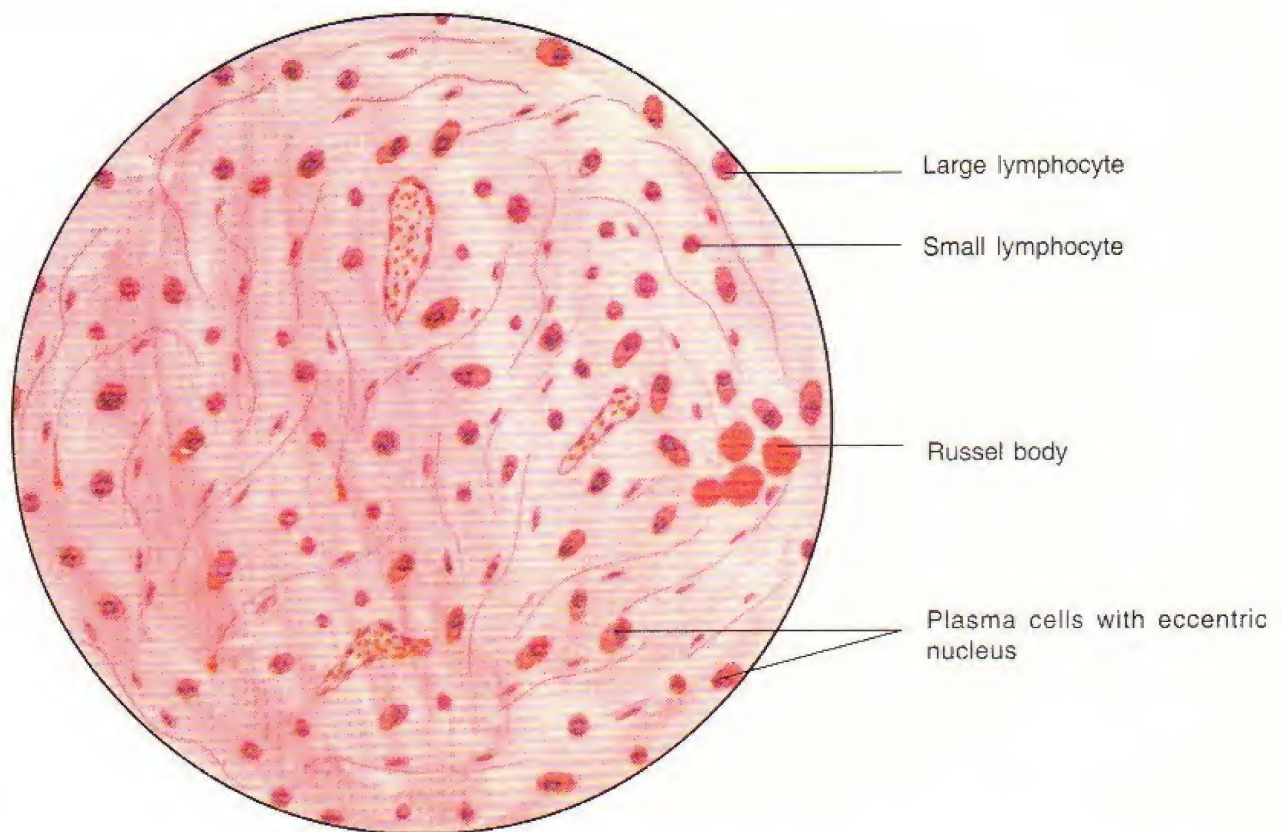


Fig. 2.8 Lymphocytes & Plasma cells

or round nucleus. The nucleus shows chromatin condensation in a radial pattern giving rise to a 'cart wheel' or 'clock face' appearance. Plasma cells are seen in connective tissue of the oral mucosa. These cells belong to the group of chronic inflammatory cells. Sometimes collection of immunoglobulin is seen as eosinophilic globules called Russel bodies in close proximity to groups of plasma cells.

Lymphocytes (Fig. 2.8)

These are defence cells of the body belonging to the group of chronic inflammatory cells. Lymphocytes can be large or small according to their size. Small lymphocytes are round cells with 6-8 microns diameter. Nucleus is round occupying the major part of cytoplasm. Only a thin rim of cytoplasm is seen around the nucleus. Large lymphocytes are larger than small lymphocytes with greater amount of cytoplasm.

Mast cells

These connective tissue cells are widely distributed in the oral mucosa. Mast cells are round or ovoid with small centrally placed nucleus. The cytoplasm contains granules rich in histamine, heparin and serotonin that have important role in allergic reaction. These cells can be seen in sections stained by toluidine blue as cells filled with magenta colored coarse granules. Mast cells are concerned with inflammation and immune response.

Giant cells (Fig. 2.9)

Large and/or multinucleated cells are called giant cells. Giant cells can be seen in physiological or pathological conditions. Osteoclast is an example for giant cells seen in physiological conditions. Commonest giant cells in pathological conditions are foreign body giant cells. They are seen in

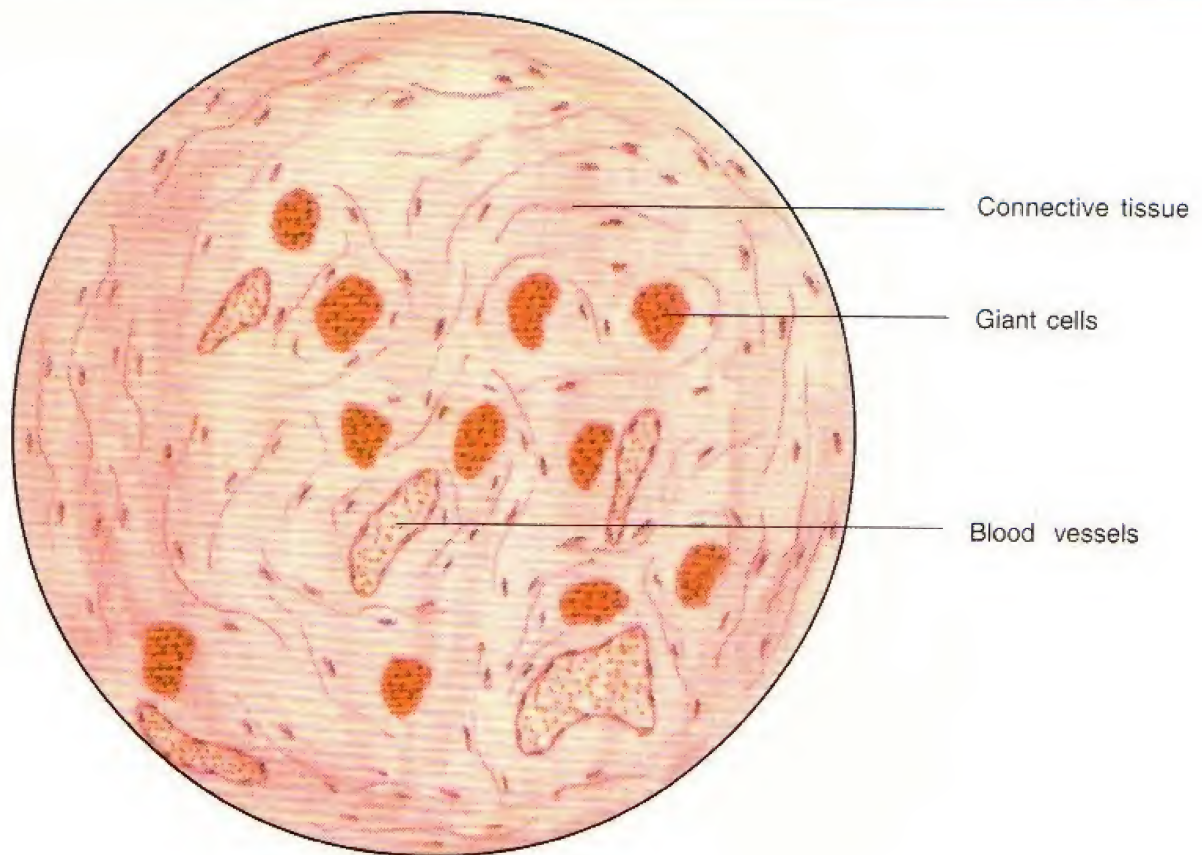


Fig. 2.9 Giant cells

chronic inflammatory reactions in relation to a foreign body. These giant cells are large cells having multiple nuclei dispersed in the cytoplasm.

Cells of odontogenic apparatus

Ameloblasts are enamel forming cells which differentiate from the cells of inner enamel epithelium of enamel organ. They are columnar in shape with approximately 40 microns in length and diameter of 4 to 5 microns. Ameloblasts shows reversal of polarity with nucleus located at the proximal end (away from the basement membrane). During formative stage, ameloblasts develop a conical projection at the basal portion which is termed as Tomes' process.

Odontoblasts are the cells which form dentin. These cells differentiate from the dental papilla of the tooth germ. Odontoblasts are located in

the pulp adjacent to the predentin with the cell body in the pulp and cell processes in the dentinal tubules. These cells are 5 to 7 microns in diameter and 25 to 40 microns in length. In the root region the odontoblasts are ovoid or spindle shaped.

Cementoblasts and cementocytes

Cementoblasts are the cells forming cementum and are derived from dental follicle of the tooth germ. These cells are cuboidal in shape and line the outer surface (periodontal ligament surface) of cementum.

Cementocytes are the cells found entrapped in cellular cementum. They are spider shaped cells which lie in spaces called lacunae. These cells have a cell body and numerous processes or canaliculi radiating from it. The canaliculi are directed towards the periodontal ligament which is the source of their nutrition.

3

Development of Teeth

- Stages of tooth development
 - Bud stage
 - Cap stage
 - Early bell stage
 - Advanced bell stage
- Development of root

Development of tooth is a complex process. The various tissues of the tooth and its supporting structures develop from tooth germ. The term tooth germ thus includes all the formative tissues for the entire tooth and its supporting structures. Tooth germ has three main components

1. Enamel organ - the ectodermal component that gives rise to enamel.
2. Dental papilla - the ectomesenchymal component that gives rise to dentin and pulp.
3. Dental follicle or dental sac - the ectomesenchymal component giving rise to cementum, periodontal ligament, and part of the alveolar socket.

STAGES OF TOOTH DEVELOPMENT

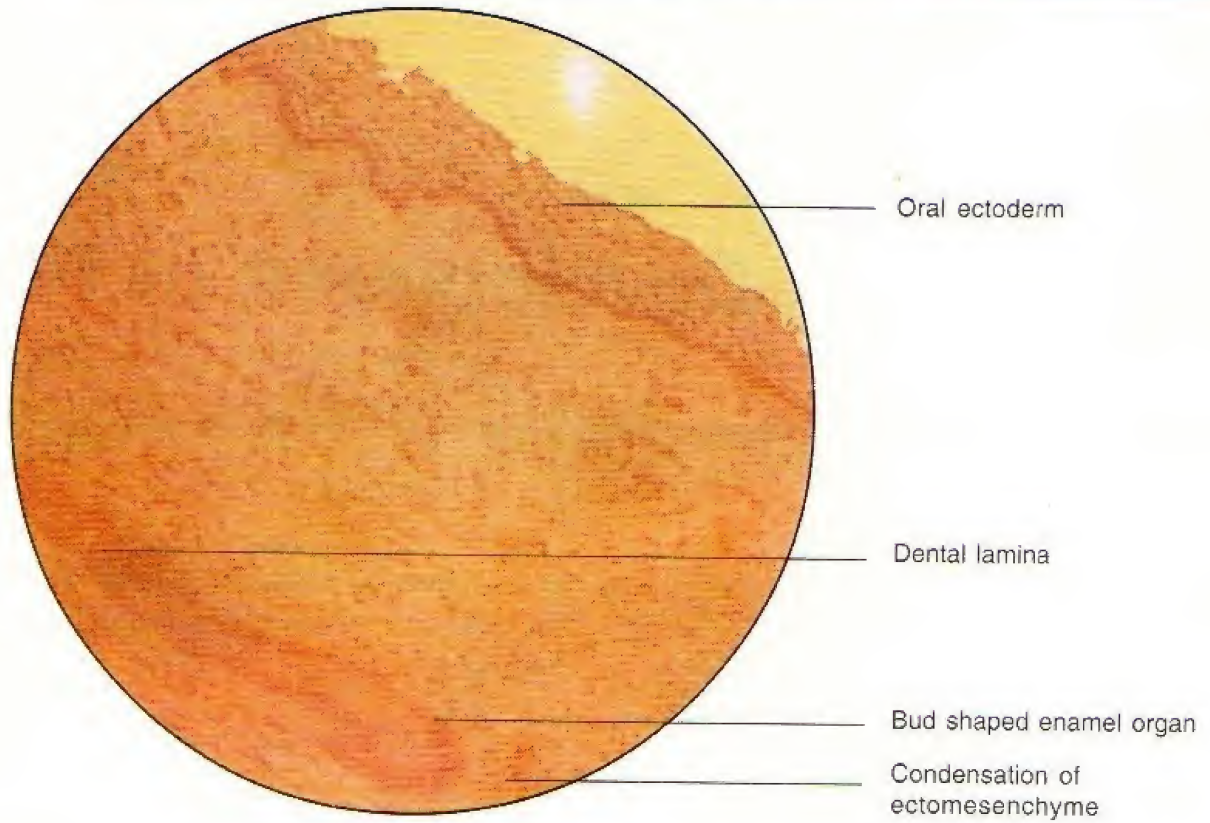
Based on the shape of enamel organ during the

development of tooth, developmental stages of the tooth are divided into three morphological stages.

1. Bud stage
2. Cap stage
3. Bell stage
 - Early
 - Late or advanced

Bud stage (Fig. 3.1)

- **Enamel organ** is bud shaped (round or ovoid) with peripheral cuboidal cells and central polyhedral cells. Peripheral cells of enamel organ are separated from ectomesenchymal components by a basement membrane. All the cells are attached to each other by desmosomal junctions.
- Ectomesenchymal condensation adjacent to enamel organ forms the **dental papilla**.
- Marginal condensation of ectomesenchymal cells enclosing dental papilla and enamel organ is called **dental follicle or dental sac**.



Bud stage of tooth development (Photomicrograph 10X)

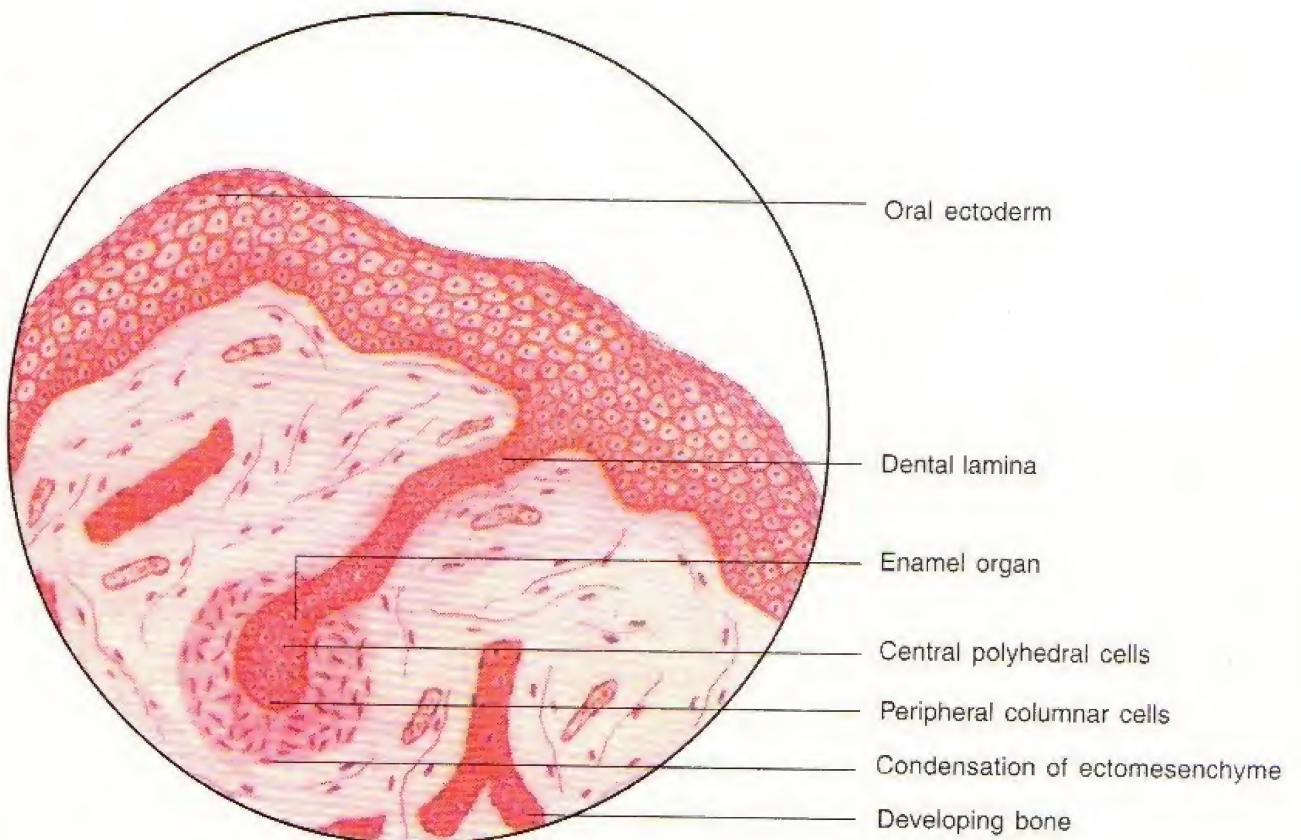


Fig. 3.1 Bud stage of tooth development



Identification Points Fig. No. 3.1

BUD STAGE

- Round or ovoid (bud shaped) enamel organ.
- Peripheral cuboidal and central polyhedral cells
- Dental papilla adjacent to enamel organ.
- Dental follicle surrounding dental papilla and enamel organ.

Cap Stage (Fig. 3.2)

Enamel organ increases in size and attain the shape of a cap by invagination of the deep portion of the bud. Cells undergo change in shape so that **three separate cell groups** can be identified. Cells lining the convexity or the periphery of the cap are cuboidal in shape and are called outer enamel epithelium. The cells lining the concave or invaginated portion change to columnar cells named as inner enamel epithelium. The central polyhedral cells transform into a network of star shaped cells called stellate reticulum.

Dental Papilla gets partially enclosed by the invaginated portion of enamel organ. Cells of dental papilla undergo proliferation and further condensation.

Dental follicle shows further condensation of



Identification Points Fig. No. 3.2

CAP STAGE

- Cap shaped enamel organ
- Three layers in enamel organ - inner enamel epithelium, stellate reticulum and outer enamel epithelium.
- Dental papilla with condensation of ectomesenchyme and budding capillaries
- Dense fibrous dental follicle.

ectomesenchymal cells. It becomes more fibrous and denser in cap stage.

Bell Stage (Fig. 3.3)

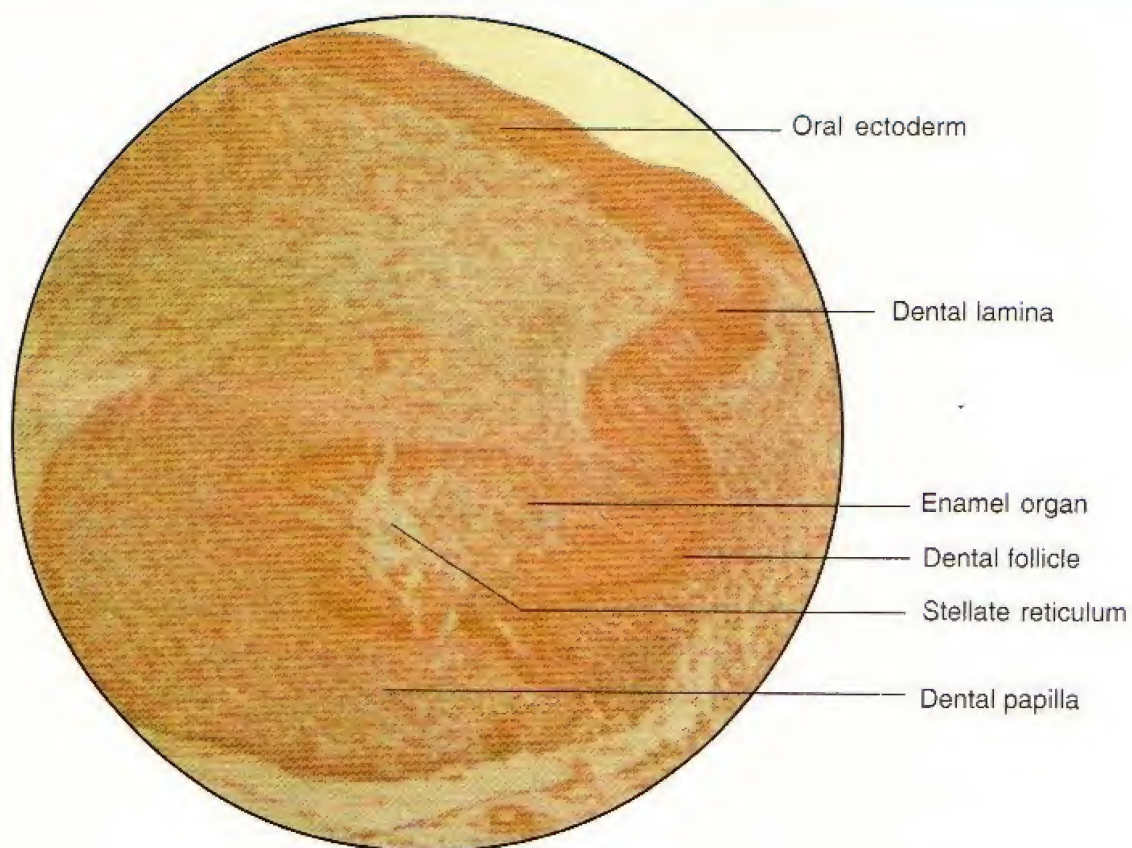
Enamel organ enlarges further and invagination deepens changing the shape to that of a bell in a longitudinal section. In bell stage **four different layers** of cells are seen in the enamel organ.

Cells lining the invaginated portion, the inner enamel epithelium is composed of single layer of tall columnar cells that differentiate to ameloblasts (enamel forming cells). During bell stage a new layer appears which is called stratum intermedium. This layer is located between inner enamel epithelium and stellate reticulum and is composed of two to three layers of squamous cells. Stellate reticulum expands further in early bell stage. Cells of outer enamel epithelium lining the periphery of enamel organ flatten to low cuboidal cells. All the cells are attached to each other by desmosomal junctions. At the cervical region of the enamel organ outer enamel epithelium loops inward to join with inner enamel epithelium. This is called cervical loop.

During early bell stage enamel organ loses its connection to oral ectoderm due to degeneration of dental lamina. Remnants of the dental lamina are called cell rests of Serres'. Successional lamina develops at this stage which is the primordium for the permanent successor.

Dental Papilla - The dental papilla is fully enclosed in the invaginated portion of the enamel organ in this stage. Peripheral cells of dental papilla differentiate into odontoblasts (dentin forming cells) under the organizing influence of inner enamel epithelial cells.

Dental follicle – becomes more fibrous, with three layers i.e. inner cellular, outer fibrous layer and middle loose connective tissue.



Cap stage of tooth development (Photomicrograph 10X)

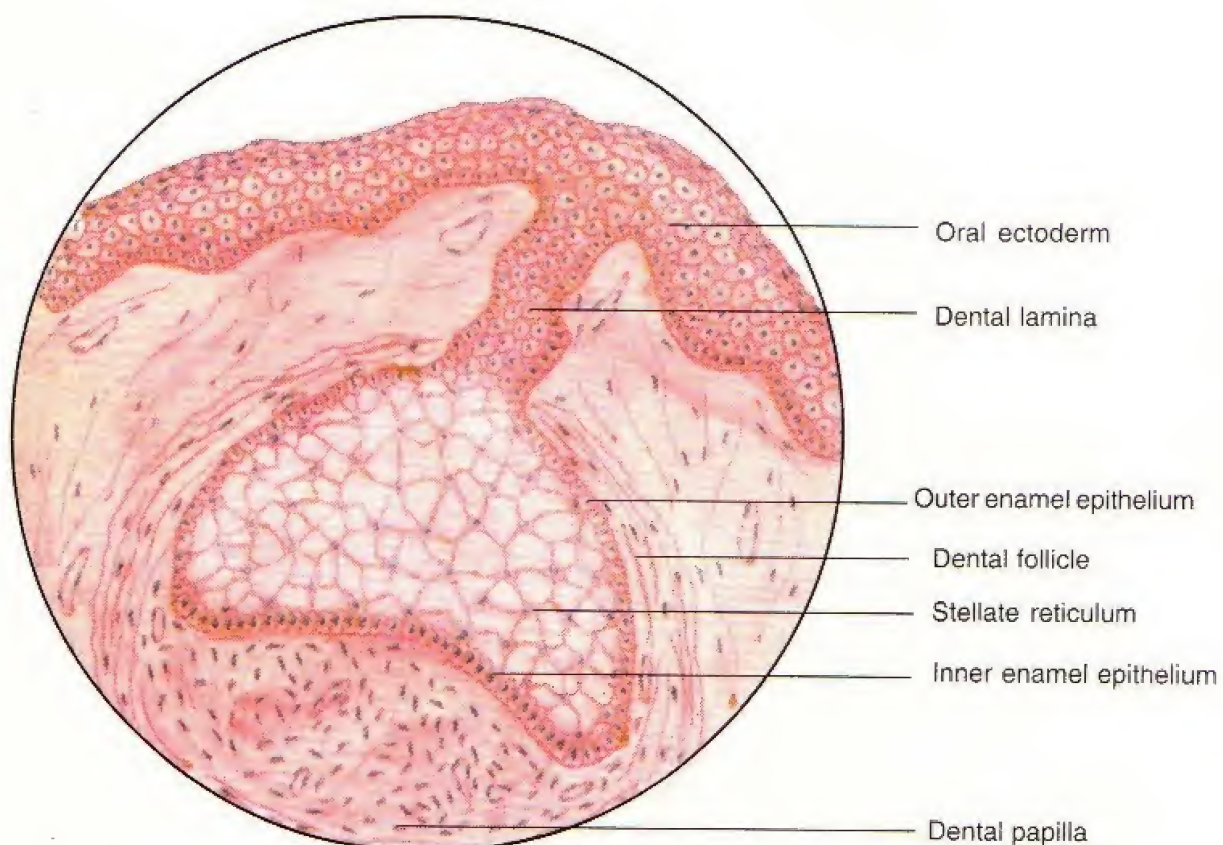
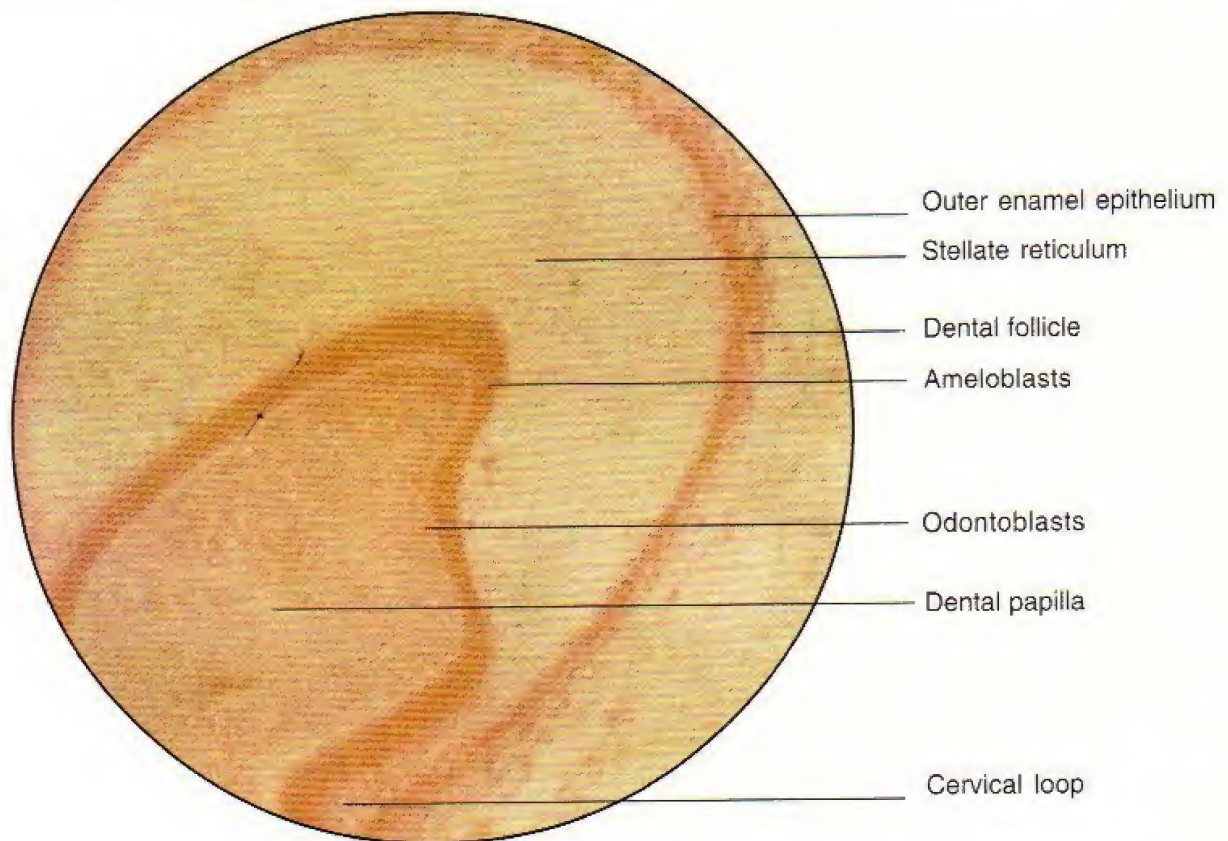


Fig. 3.2 Cap stage of tooth development



Early bell stage of tooth development (Photomicrograph 10X)

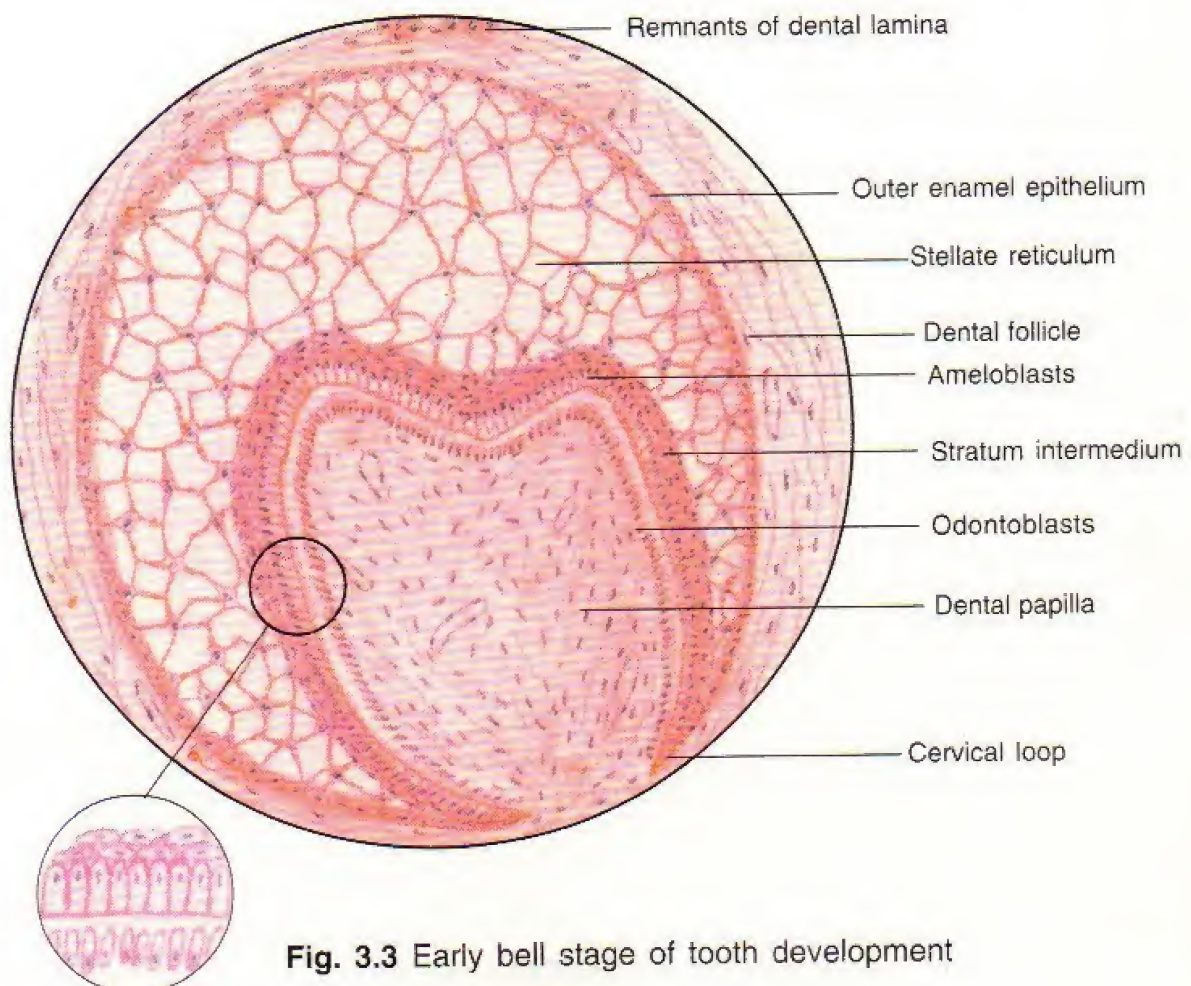


Fig. 3.3 Early bell stage of tooth development

**Identification Points Fig. No. 3.3****EARLY BELL STAGE**

- Enamel organ having bell shape
- Four layers in enamel organ - inner enamel epithelium, stratum intermedium, stellate reticulum and outer enamel epithelium
- Dental papilla with peripheral cells differentiating to odontoblasts
- Distinct dental follicle.

Advanced bell stage (Fig. 3.4)

Differentiating feature between early and advanced bell stage is formation of hard tissues.

Enamel organ shows four different layers, inner enamel epithelium (ameloblasts) stratum intermedium, stellate reticulum and outer enamel epithelium.

Histological differences from early bell stage are -

- Hard tissue (enamel and dentin) formation
- Collapsed stellate reticulum and folding of outer enamel epithelium bringing capillaries of the dental follicle nearer to the ameloblasts.

Ameloblasts are brought closer to the dental follicle which now becomes their source of nutrition.

**Identification Points Fig. No. 3.4****ADVANCED BELL STAGE**

- Dentin and enamel formation
- Four distinct layers of enamel organ, collapse of stellate reticulum
- Distinct layer of odontoblasts
- Distinct dental follicle

Dental papilla shows differentiated odontoblast at the periphery.

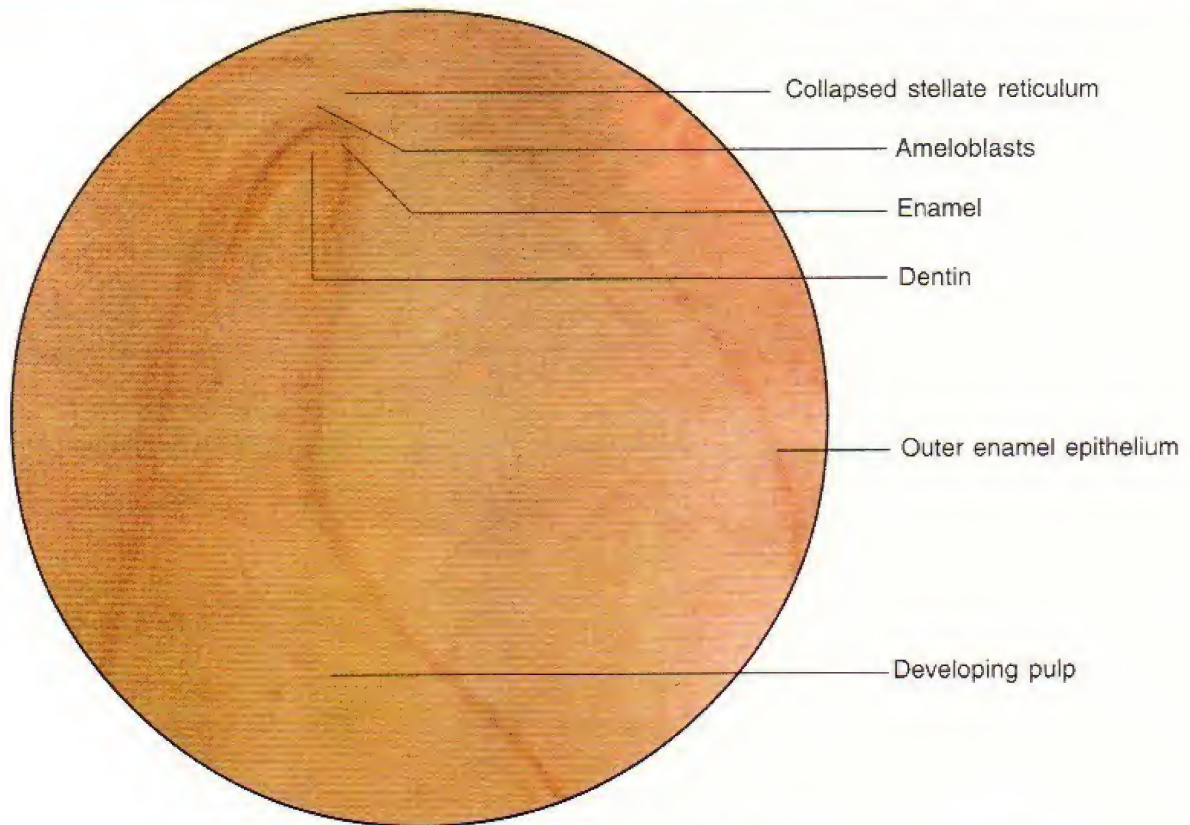
Dental Follicle is distinct enclosing enamel organ and dental papilla.

Development of root (Fig. 3.5)

Root development occurs in advanced bell stage after the enamel and dentin formation reaches the cervical region of tooth. The cervical loop which is composed of outer and inner enamel epithelium, proliferates to form Hertwig's epithelial root sheath (HERS) which determines the size, shape and number of roots to be formed. Inner cells of HERS exert an organizing influence on dental papilla cells to differentiate in to odontoblasts that deposit radicular dentin. Once the root dentin is formed HERS degenerates allowing the dental follicle cells to come in contact with dentin. The cells of dental follicle differentiate to form cementoblasts and lays down cementum over the root dentin. As the cementum formation progresses, the rest of the dental follicle becomes more fibrous and develops into periodontal ligament. The remnants of HERS remain in periodontal ligament and are called 'cell rests of Malassez'. Under pathological conditions these cell rests may proliferate giving rise to odontogenic cysts or tumors.

**Identification Points Fig. No. 3.5****DEVELOPMENT OF ROOT**

- Formation of Hertwig's epithelial root sheath
- Formation of radicular dentin
- Degeneration of Hertwig's epithelial root sheath
- Formation of radicular cementum
- Orientation of periodontal ligament fibers



Advanced bell stage of tooth development (Photomicrograph 4X)

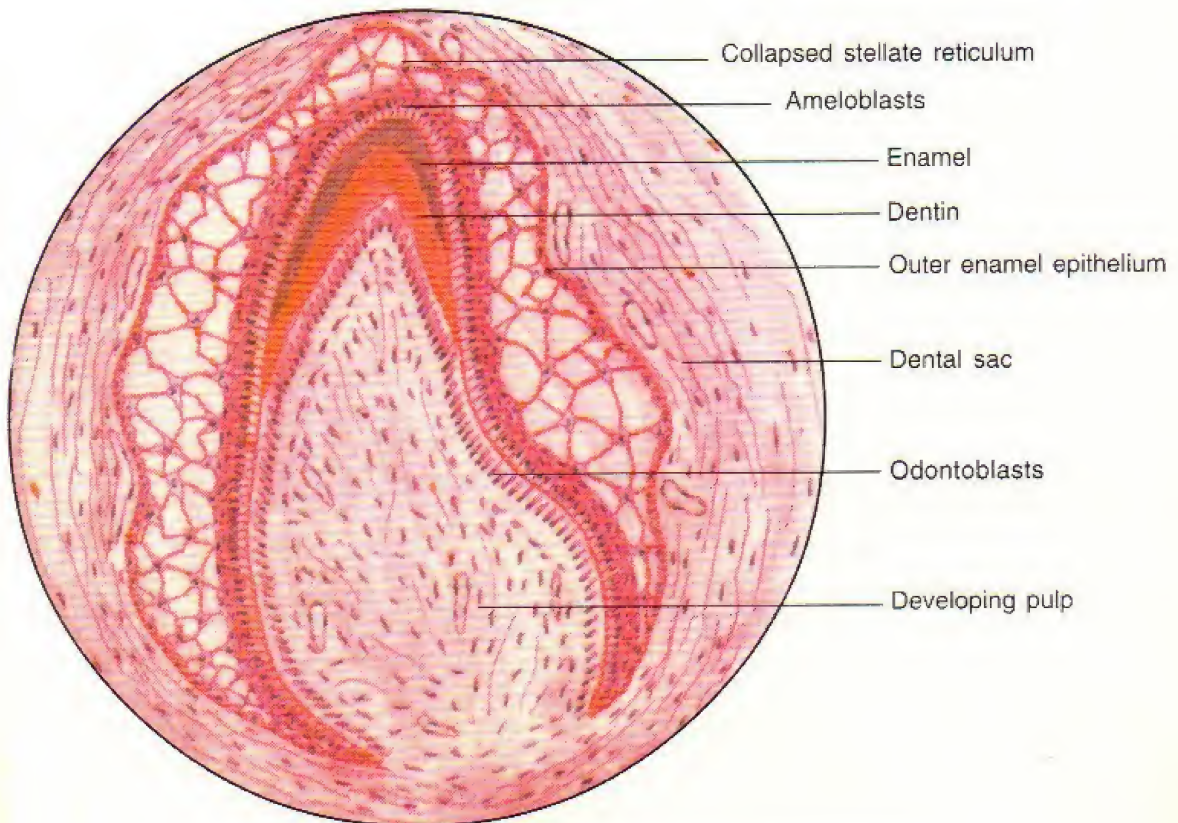


Fig. 3.4 Advanced bell stage of tooth development

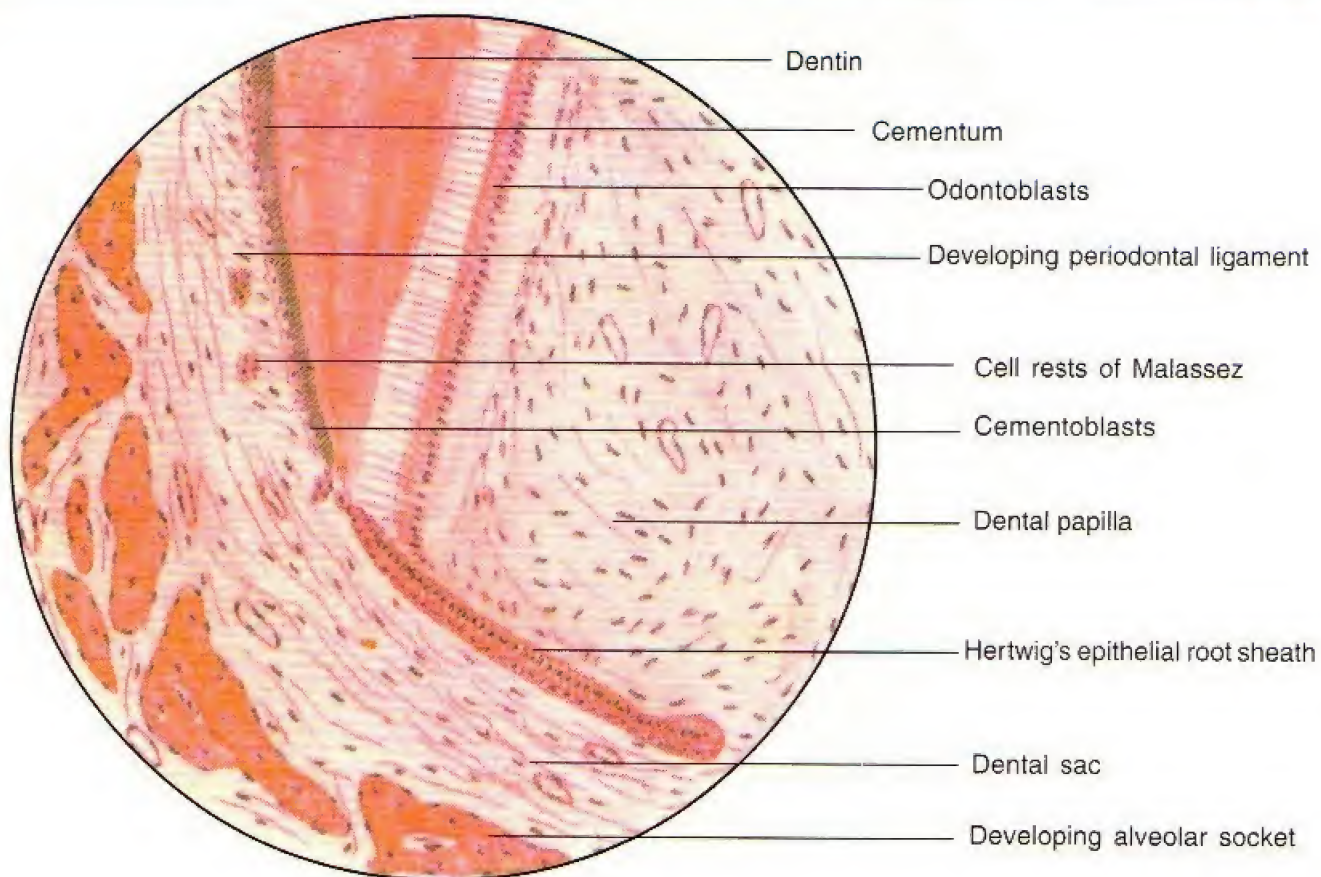


Fig. 3.5 Development of root

4

Enamel

- Structure of enamel rod
- Striae of Retzius
- Neonatal line
- Enamel lamellae
- Enamel tufts
- Enamel spindle
- Hunter Schreger bands
- Gnarled enamel

Enamel is the hardest calcified tissue of the body covering the anatomic crown of the tooth. Enamel, in contrast to other calcified structures of the body, is ectodermal in origin, has 96% inorganic component, and unique organic constituent which do not contain collagen. Structure of enamel is studied using ground sections. Decalcified sections are not of much use because enamel is lost during decalcification due to its high mineral content.

Enamel rods (Fig. 4.1 & 4.2)

Enamel rods are the basic structural units of enamel. They run from the dentinoenamel junction to the outer surface of enamel and follow somewhat tortuous course. In a longitudinal

section (Fig. 4.1) enamel rods appears to be divided into segments by dark lines. These dark lines across the enamel rods are called cross striations. These cross striation are separated by a distance of 4 microns making each segment 4 microns which is the increment of enamel deposited daily.

In cross section (Fig.4.2) enamel rods may resemble a fish scale or keyhole pattern with a head and a tail. Head represents the rods and tail represents the inter rod region. The head portion is directed towards the occlusal aspect and tail to the cervical region of the tooth.



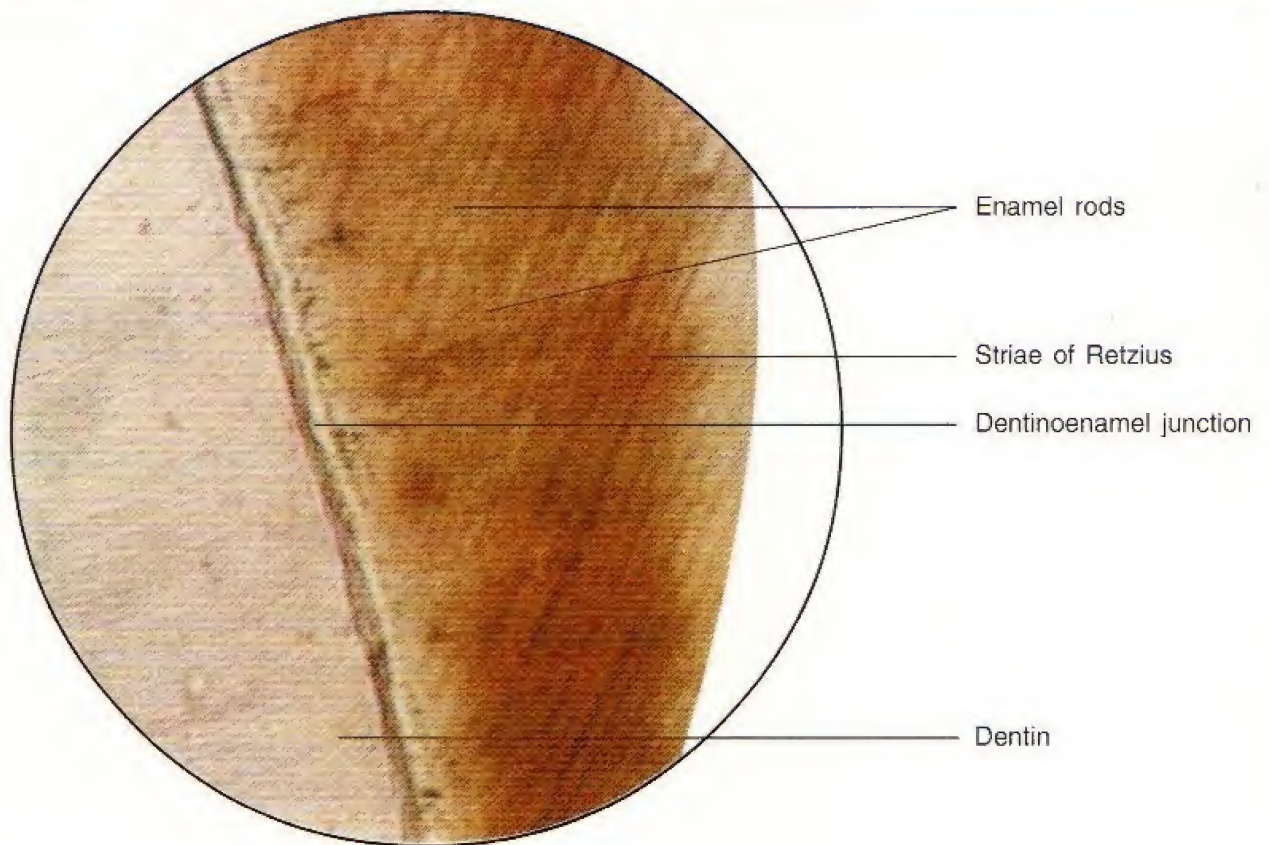
Identification Points Fig. No. 4.1 & 4.2

ENAMEL RODS

- Basic structural units of enamel
- Rod shaped in longitudinal sections
- Resemble fish scale or key hole in cross section.

Striae of Retzius (Fig. 4.3)

Striae of Retzius are the incremental lines of enamel representing the successive apposition of enamel. These structural lines appear as



Enamel rods - Longitudinal section (Photomicrograph 10X)

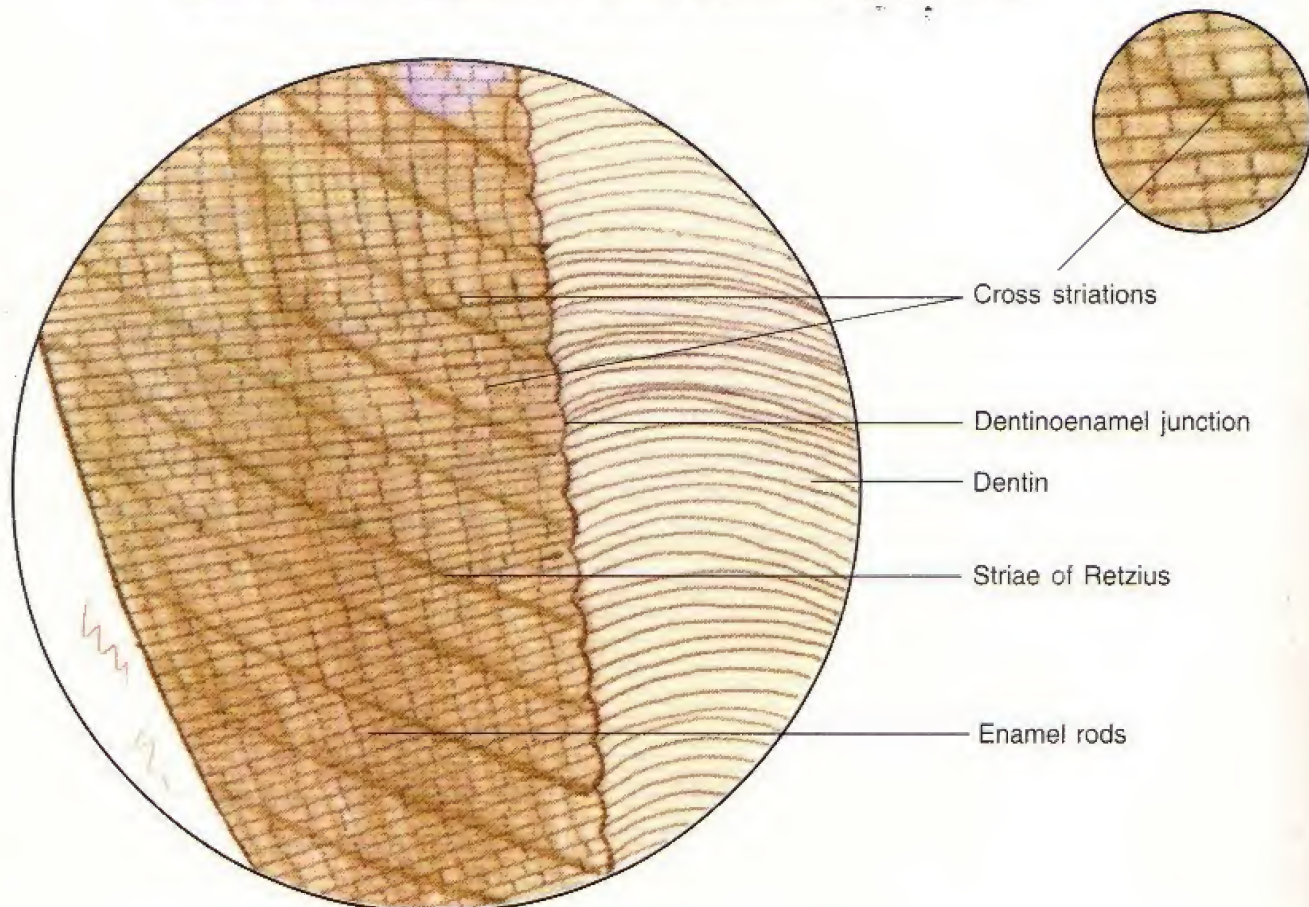


Fig. 4.1 Enamel rods - Longitudinal section

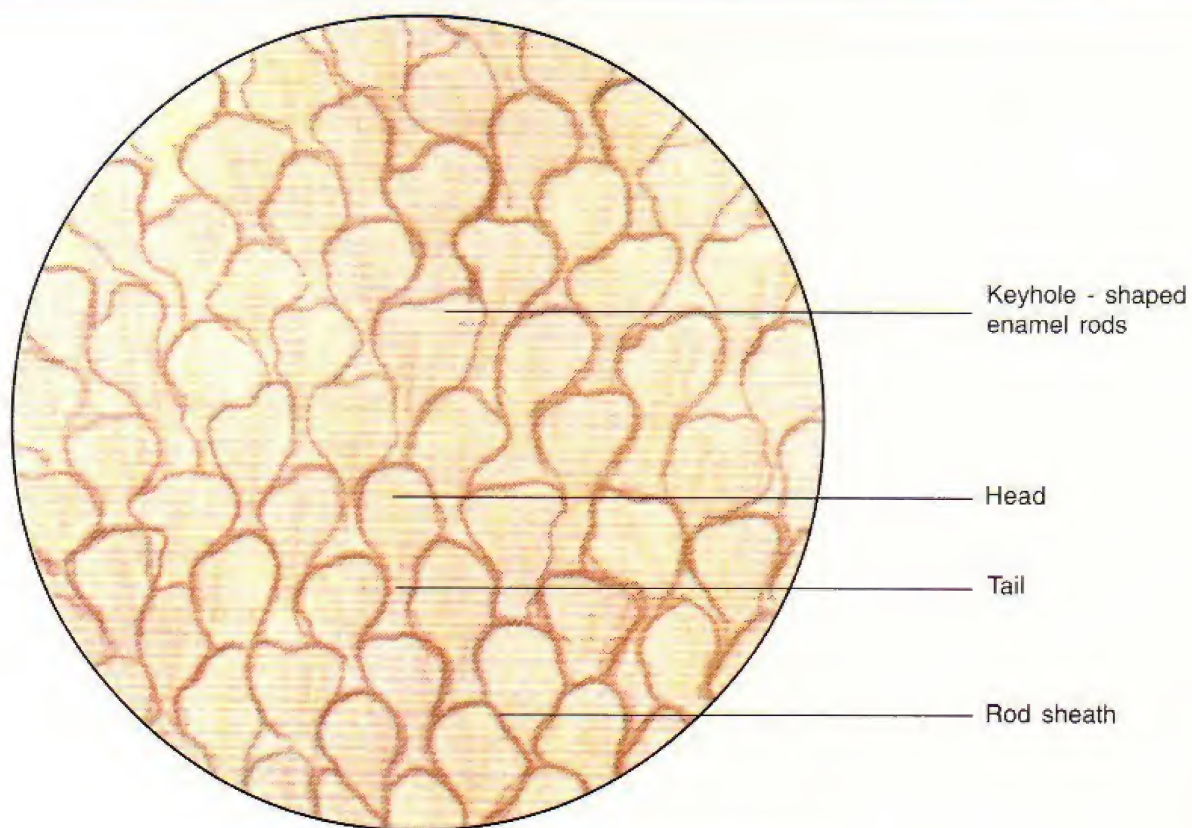


Fig.4.2 Enamel rods - transverse section

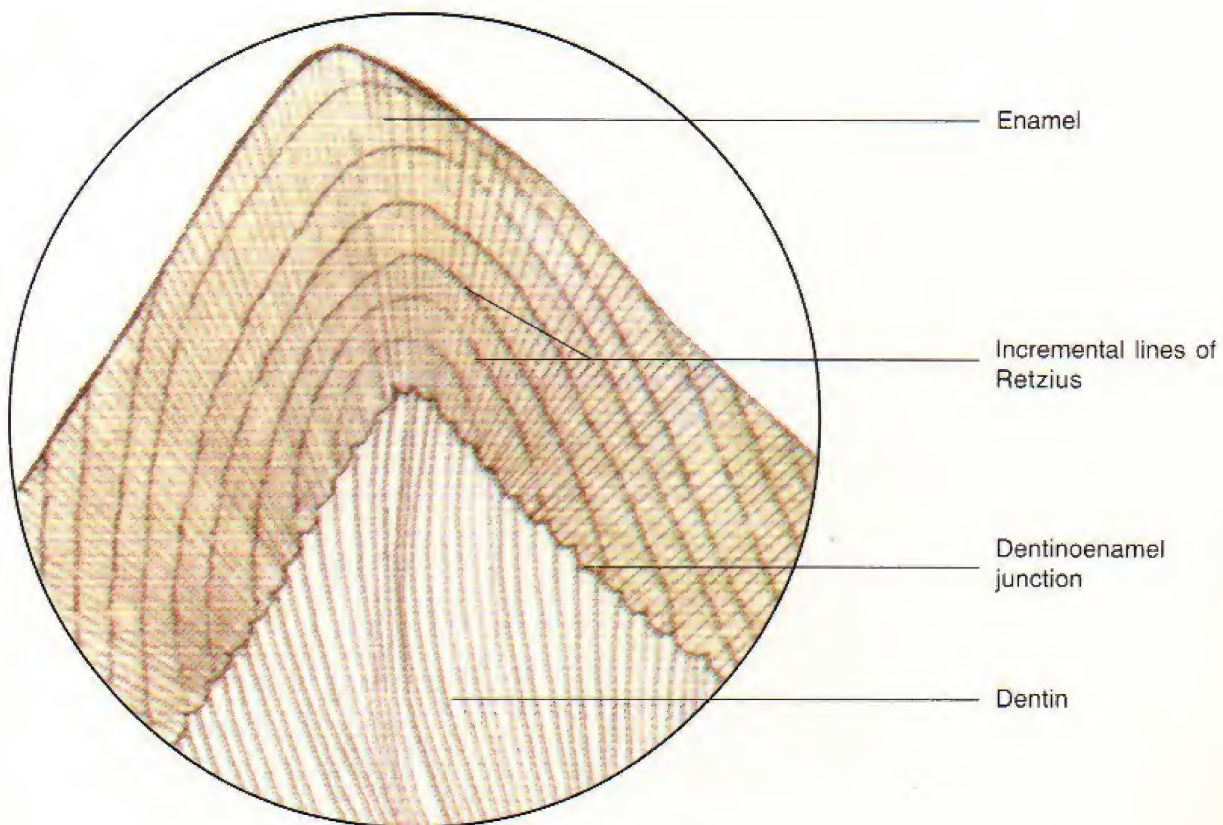


Fig. 4.3 Striae of Retzius

**Identification Points Fig. No. 4.3****STRIAE OF RETZIUS**

- Incremental lines of enamel.
- Appears as brownish bands in ground section
- Hypo calcified structures

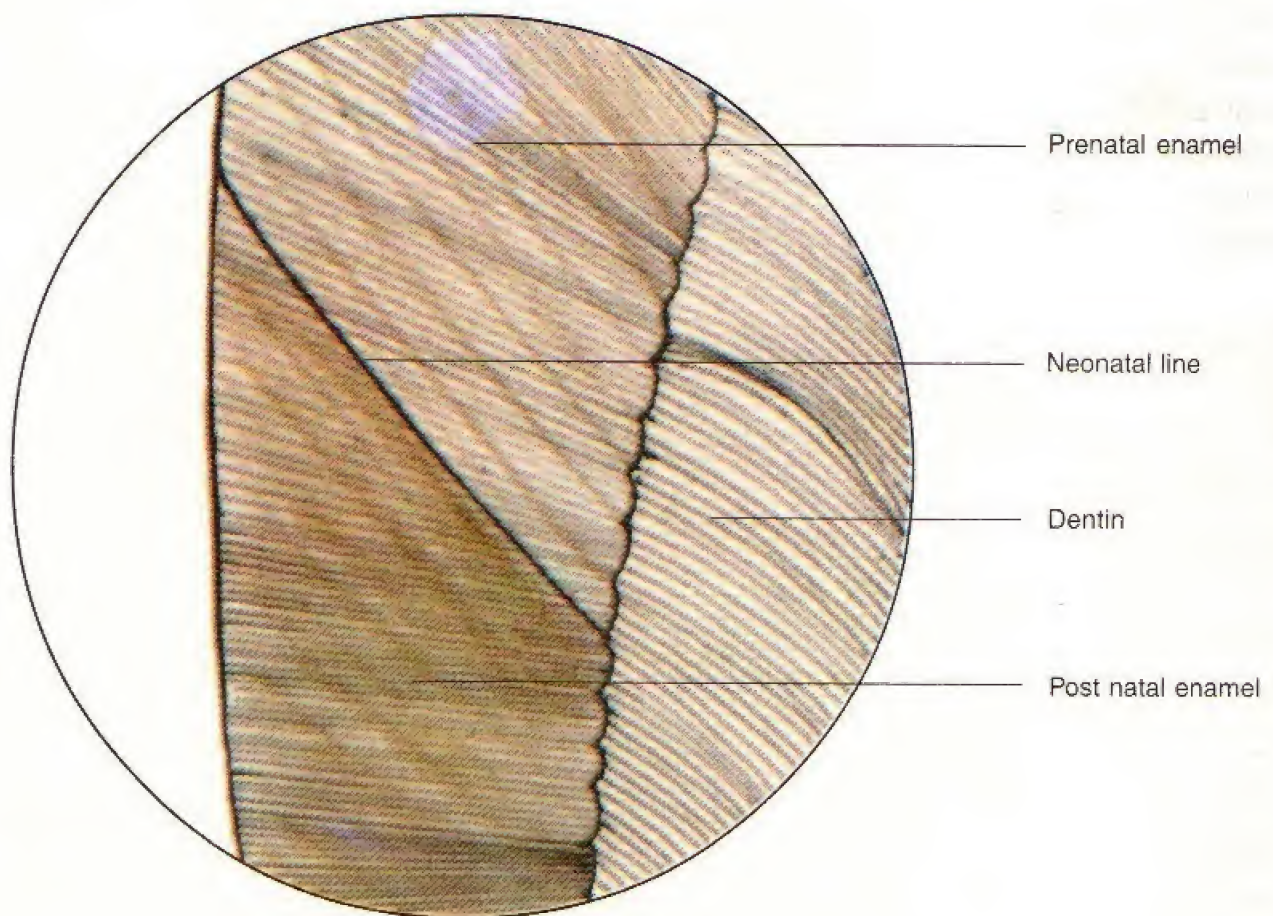
brownish bands in ground sections. In the region of incisal edge and cusps they surround the dentin while in cervical region they are seen as oblique lines extending from DEJ towards the outer surface deviating in an occlusal direction. In transverse sections of teeth incremental lines are seen as concentric rings. These lines are hypocalcified and reflect variation in structure and mineralization.

Neonatal line (Fig. 4.4)

Neonatal line is prominent incremental line that separates the enamel that is formed before birth (prenatal enamel) and after birth (post natal enamel). The incremental line becomes prominent because of abrupt change in the environment that occurs at the time of birth. The neonatal line is seen in all deciduous teeth and first permanent molars where enamel is formed partly before birth and partly after.

**Identification Points Fig. No. 4.4****NEONATAL LINE**

- Accentuated incremental line.
- Separates pre and post natal enamel.
- Seen in all deciduous teeth and first permanent molars.

**Fig.4.4 Neonatal line**

Enamel lamellae (Fig. 4.5)

Enamel lamellae are leaf like structures that extend from the outer surface of enamel towards the dentin. These are hypocalcified structures and are formed in planes of tension.

Three types of lamellae are seen.

Type A - Composed of poorly calcified enamel rods. This type is restricted to enamel

Type B - Consists of degenerated cells and may extend into dentin.

Type C - Filled with organic matter derived from saliva. This type is formed after the eruption of the tooth and may be extended into the dentin.

Enamel tufts (Fig. 4.5)

Enamel tufts are ribbon like structures extending from dentinoenamel junction into enamel to a distance of one third to one fifth of enamel thickness. In thick sections these ribbon like structures arising from different planes are projected to one plane giving the appearance of tuft of grass. These are hypocalcified structures containing greater concentration of organic

components. Enamel tufts are better visualized in transverse sections.

Enamel spindle (Fig. 4.6)

The enamel spindles are the odontoblastic processes crossing the dentinoenamel junction and extending to the enamel. These are spindle shaped structures extending from dentinoenamel junction to enamel to a distance of approximately 10 microns. They appear dark in a ground section under transmitted light because the organic content of spindle is lost and is replaced by air. Enamel spindles are seen more in the region of cusp tip.



Identification Points Fig. No. 4.6

ENAMEL SPINDLES

- Odontoblast processes extending to enamel.
- Appears as dark spindle shaped structure
- Found more in the cuspal region.



Identification Points Fig. No. 4.5

ENAMEL LAMELLAE

- Hypo calcified structures of enamel.
- Extend from outer surface of enamel towards the dentin.
- Type A,B, or C can be seen.

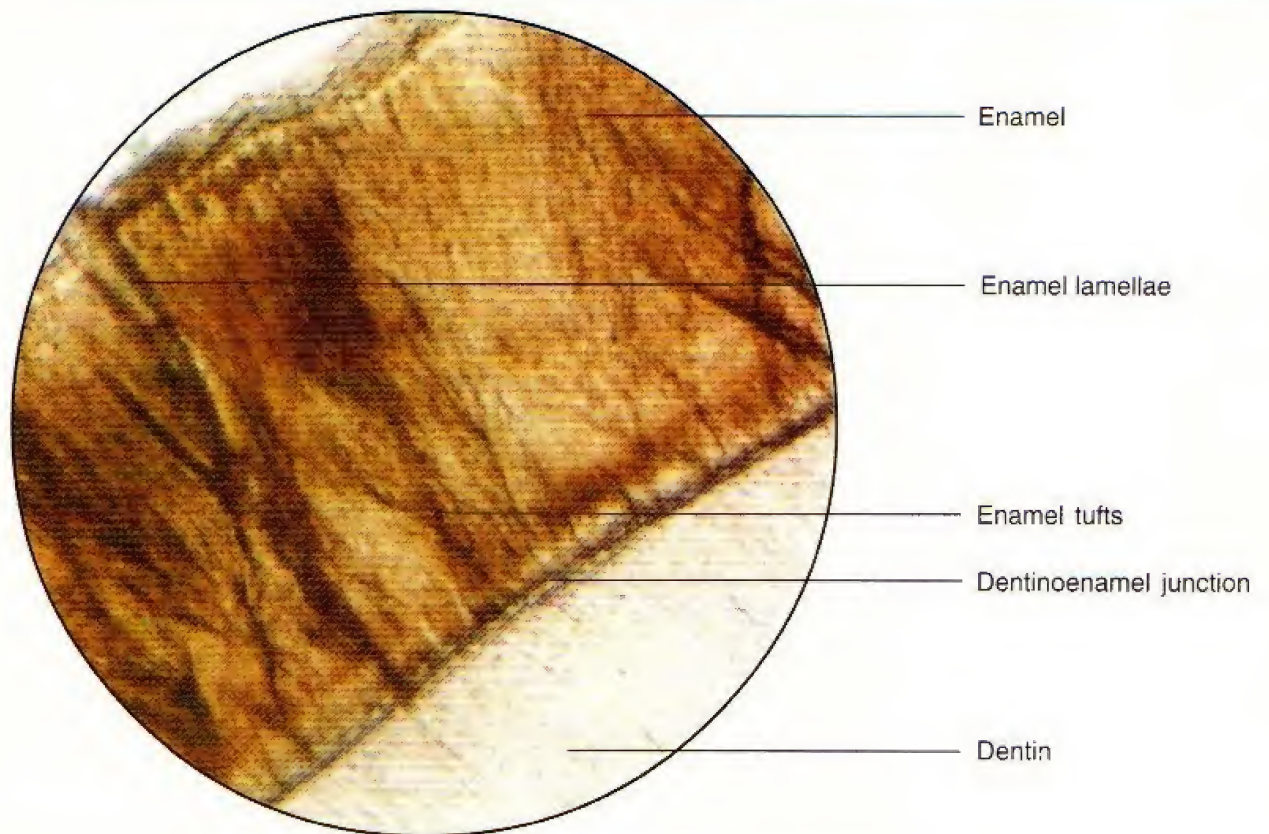
ENAMEL TUFTS

- Hypo calcified structure of enamel.
- Ribbon like structures extending from DEJ to enamel to a distance of one third to one fifth of enamel thickness.
- Resemble tufts of grass in ground section.

Hunter Schreger bands (Fig. 4.7)

Hunter Schreger bands(HS bands) are alternate dark and light bands of varying width observed in enamel when a longitudinal section is viewed under reflected light. These bands arise from the dentinoenamel junction and pass outward till the inner 2/3 of enamel thickness. These bands are slightly curved with convexity directed to the cervical region. HS bands are not seen in outer 1/3 of enamel, because the enamel rods are straight in this region.

HS bands are formed due to change in direction of enamel rods. Because of this change in direction, when a longitudinal section is made some prisms are cut longitudinally and some transversely. When viewed under reflected light those prisms lying parallel to the light beam would



Enamel lamellae & Enamel tufts (Photomicrograph 4X)

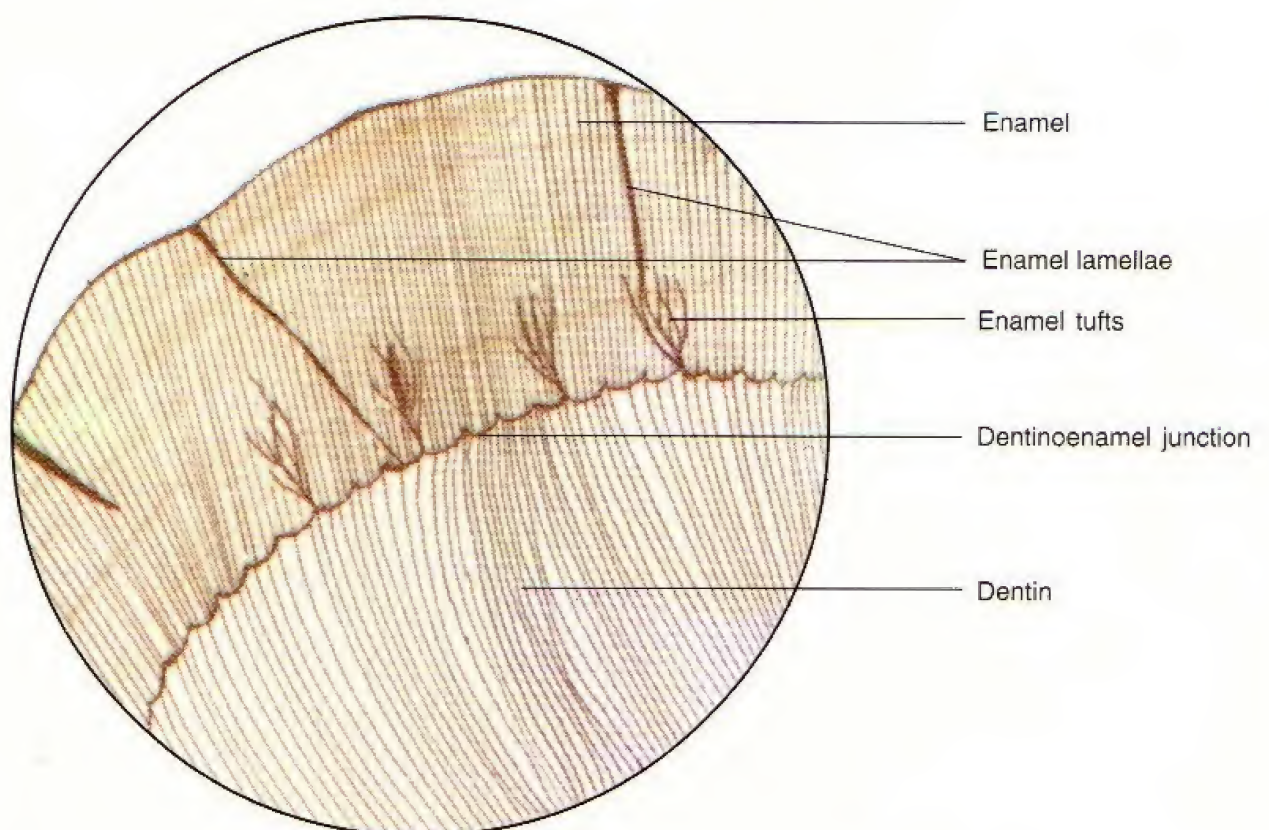


Fig. 4.5 Enamel lamellae & Enamel tufts

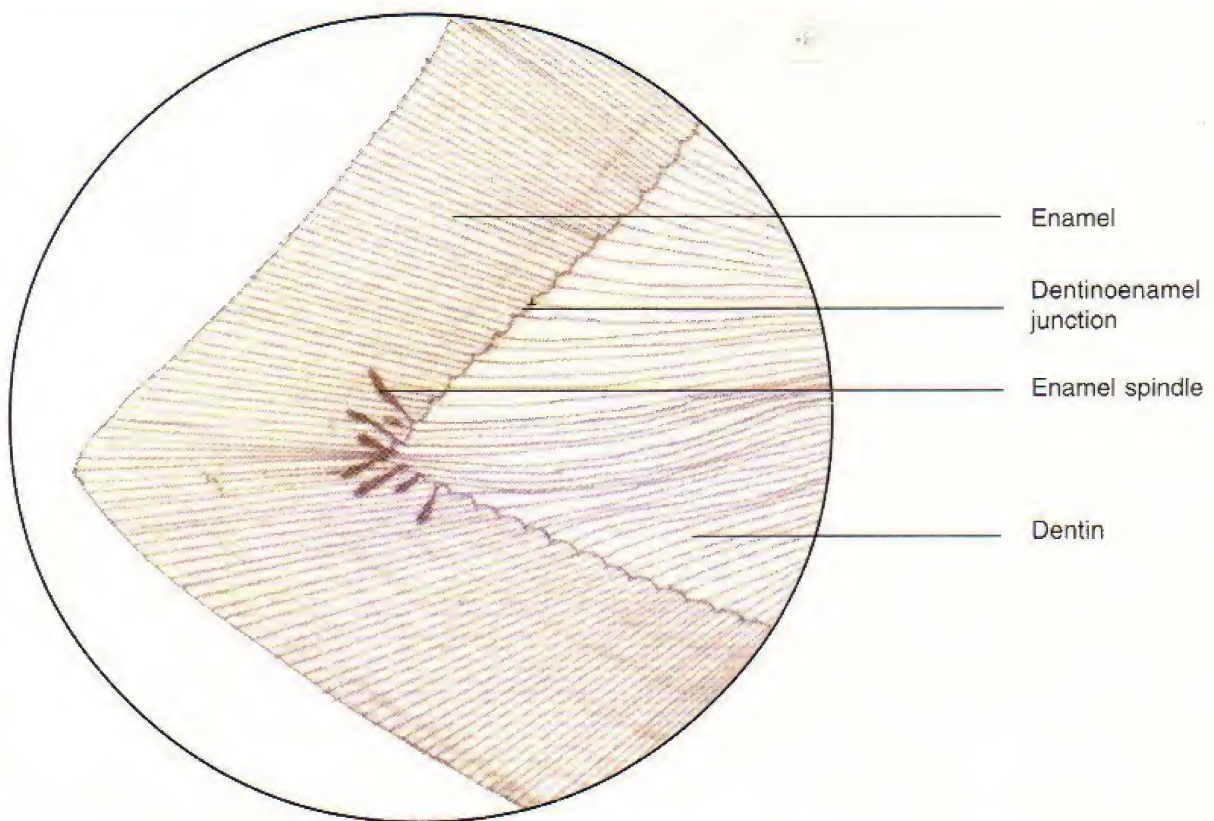


Fig.4.6 Enamel spindles



Fig. 4.7 Hunter - Schreger bands

**Identification Points Fig. No. 4.7****HUNTER - SCHREGER BAND**

- Appear as alternate light and dark bands
- Seen under reflected light
- Occur due to abrupt change in direction of enamel rods.

reflect the light away from microscope and appear as dark bands. The prisms lying less parallel to the light would reflect the light through the microscope and appear bright. There is also an opinion that the dark and light bands of Hunter-Schreger bands may be composed of zones having altered permeability, difference in organic component or an area with variation in calcification.

Gnarled enamel (Fig. 4.8)

Enamel rods follow a wavy course as they extend

from dentinoenamel junction towards the outer surface. In the region of the cusps and incisal edges the arrangement of enamel rods are more complicated. The enamel rods are more wavy and irregular and intertwine with each other in this region especially near DEJ. This arrangement creates an optical appearance referred to as gnarled enamel. This particular arrangement of rods in cuspal and incisal region makes enamel stronger to withstand masticatory stress.

**Identification Points Fig. No. 4.8****GNARLED ENAMEL**

- Optical appearance seen in the incisal or cuspal region.
- Occur due to wavy intertwining enamel rods.
- This arrangement makes enamel stronger.

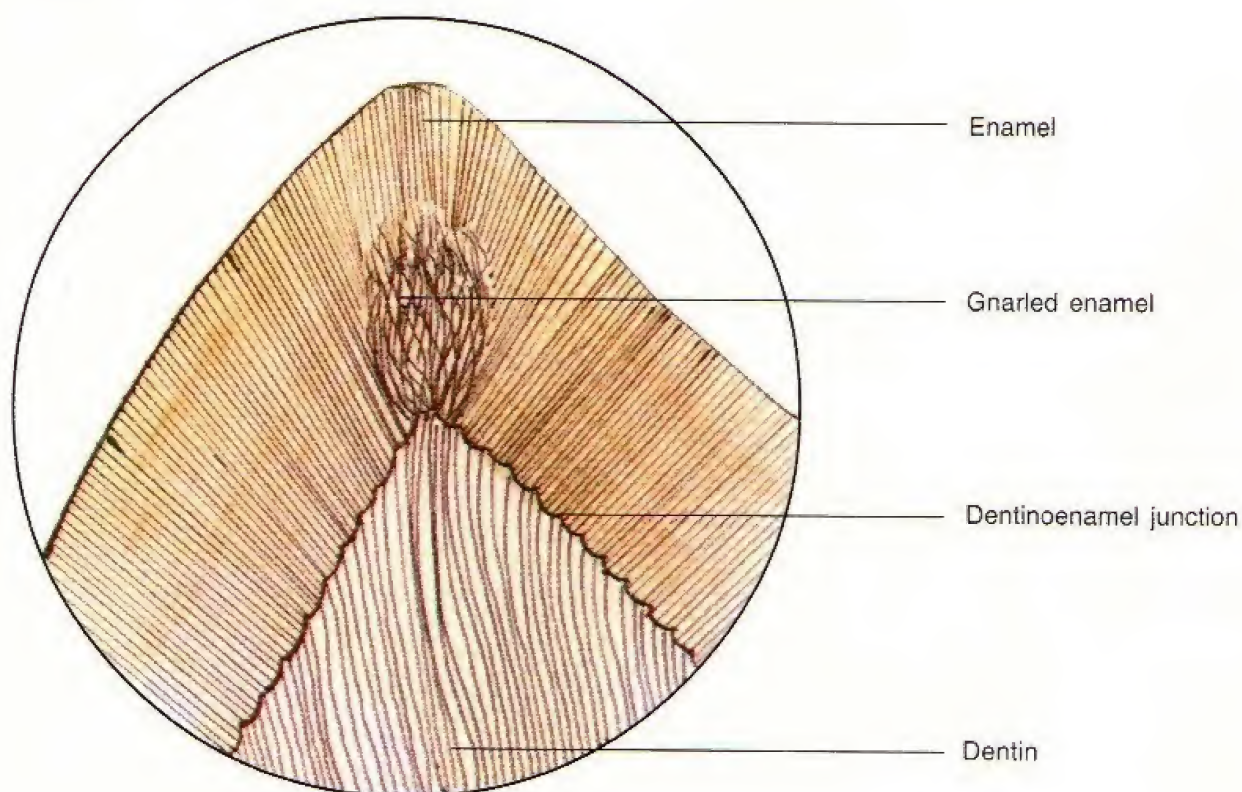


Fig.4.8 Gnarled enamel

- Structure of dentinal tubules
 - 'S' shaped dentinal tubules
 - 'Y' shaped terminal branching
 - Transverse section of dentin
- Dentinoenamel junction
- Incremental lines of dentin
- Interglobular dentin
- Tomes' granular layer
- Dead tracts

Dentin is the hard tissue component that makes up the bulk of the tooth. The structure of dentine can be studied using ground sections or decalcified sections under light microscope. The structural features seen under light microscope are dentinal tubules, which are the basic structural units of dentin, peritubular or intratubular dentin, intertubular dentin, incremental lines, interglobular dentin and Tomes' granular layer. Functional changes may be evident like dead tracts, reparative dentin and sclerotic dentin.

'S' shaped dentinal tubules (Fig. 5.1)

Dentinal tubules extend from pulpal surface to dentinoenamel or dentinocemental junction. Dentinal tubules are 'S' shaped or doubly curved structures and is described as primary curvature

of dentinal tubules. The first convexity from the pulpal side is directed towards the root of tooth and second convexity towards the crown. These tubules are perpendicular to pulpal surface and dentinoenamel junction. Along the length of primary curvature small oscillations will be found at intervals and are referred to as secondary curvatures.



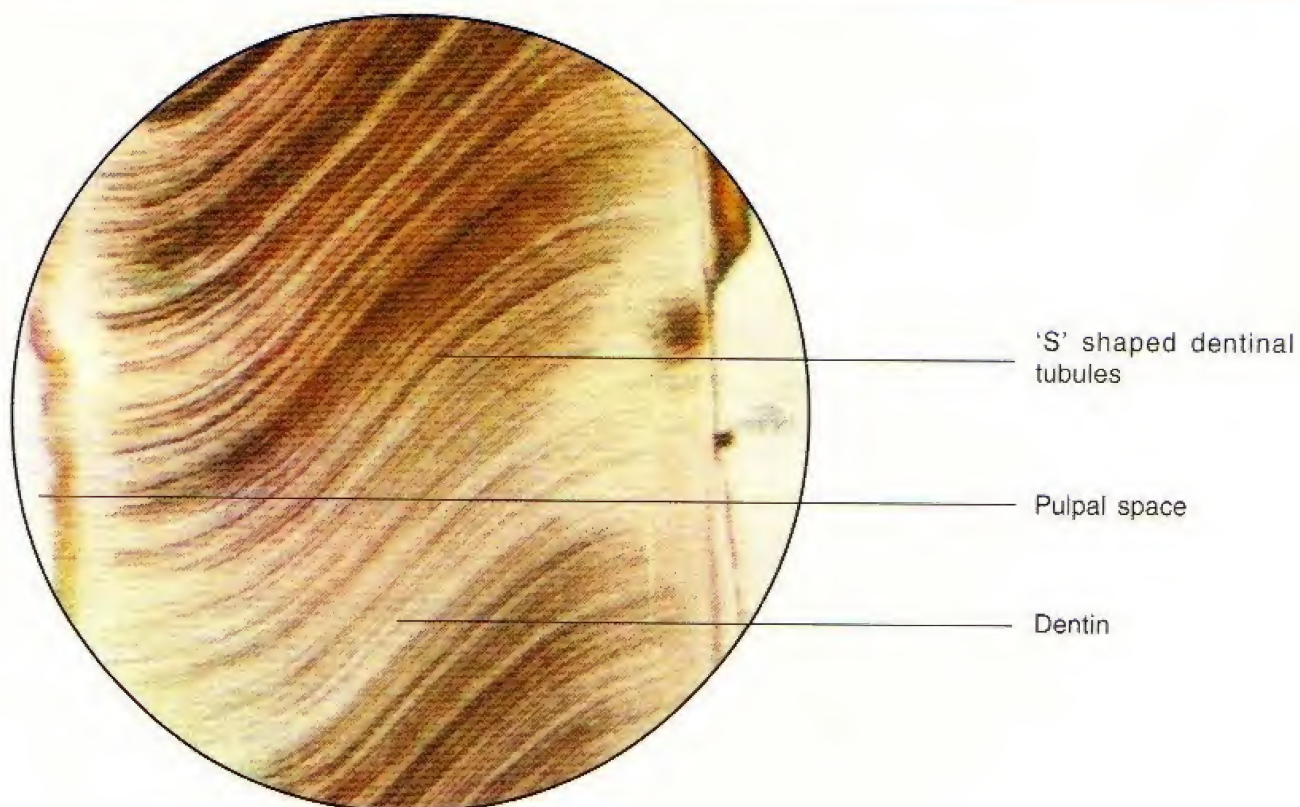
Identification Points Fig. No. 5.1

'S' SHAPED DENTINAL TUBULES

- First convexity from pulpal side directed towards the root
- Second convexity directed towards the crown.
- All along the course secondary curvatures are seen.

'Y' shaped terminal branches and lateral branches of dentinal tubules (Fig. 5.2)

The terminal end of dentinal tubule near dentinoenamel junction fork off from the main tubule at 45 degree to form 'Y' shaped terminal branching. Some of the odontoblastic processes may cross the dentinoenamel junction to form enamel spindles.



'S' shaped dentinal tubules (Photomicrograph 4X)

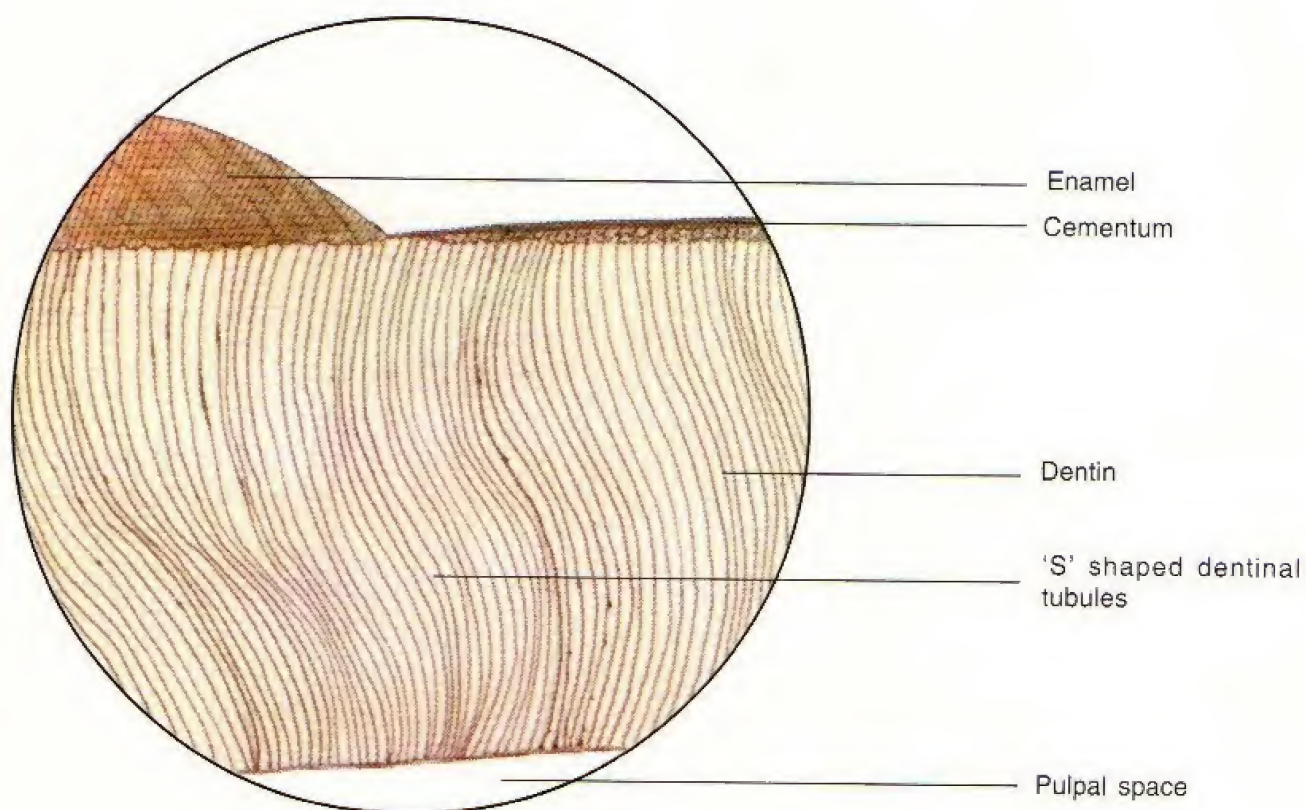


Fig. 5.1 'S' shaped dentinal tubules

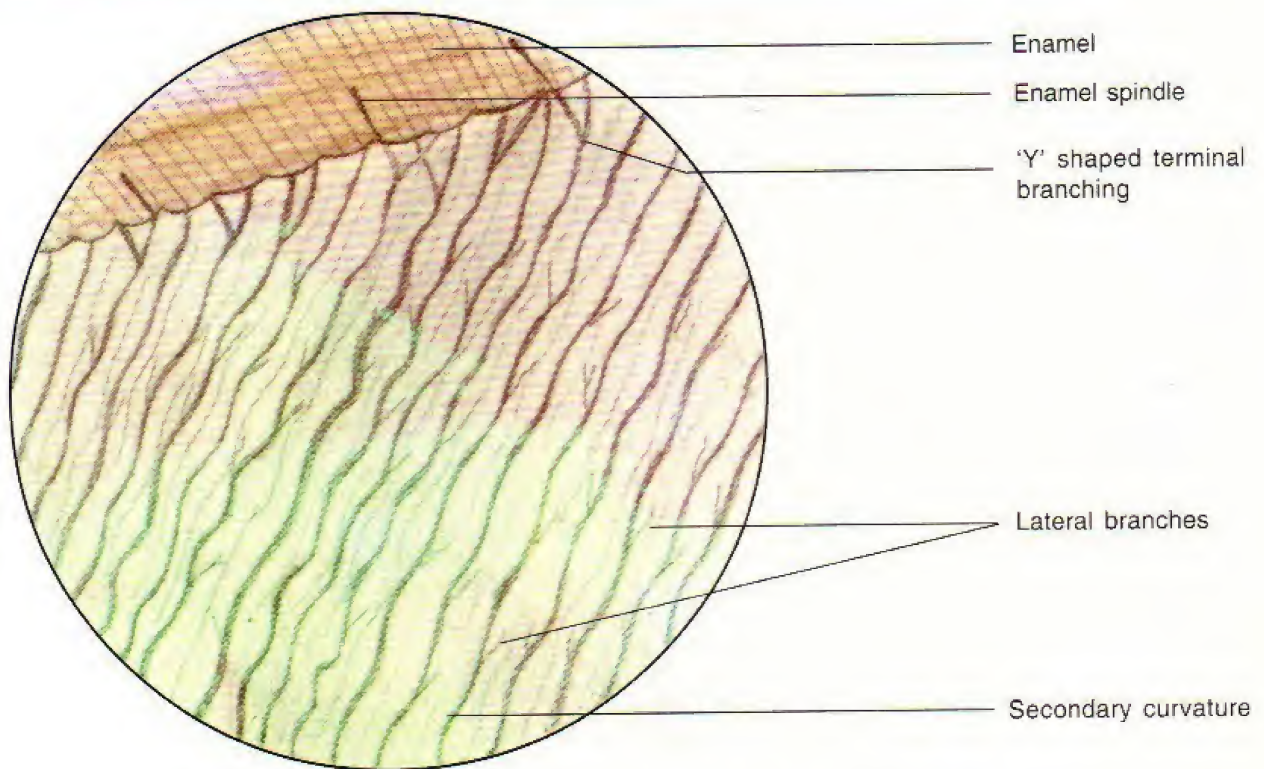


Fig.5.2 Terminal branches & lateral branches of dentinal tubules

KEY



Identification Points Fig. No. 5.2

TERMINAL & LATERAL BRANCHES OF DENTINAL TUBULES

- Near DEJ, terminal end of dentinal tubules show 'Y' shaped branching.
- Lateral branches are seen along the course
- Lateral branches may contain odontoblast process

Also all along the course, the tubules have lateral branches at every 1 micrometer distance. These lateral branches are at an angle of 45° to the tubule and may contain odontoblast processes. Lateral branches may communicate with those of adjacent tubules or blindly end at intertubular dentin.

Transverse section of Dentin (Fig. 5.3)

Transverse or cross section of dentin shows

numerous dentinal tubules appearing as circular structures. These tubules have odontoblast processes at the center that appear as dark spot with peritubular space surrounding it. The peritubular space contains tissue fluid named as dental lymph. The inner aspect of the tubule is thought to be lined by an organic membrane called lamina limitans. The dentinal tubules are surrounded by peritubular or intratubular dentin. In between the dentinal tubules the bulk of dentin is made of intertubular dentin.

KEY



Identification Points Fig. No. 5.3

T. S OF DENTIN

- Dentinal tubules appear as circular structures.
- Within the tubules odontoblast process is seen.
- Around the tubule peritubular dentin & in between intertubular dentin are seen.

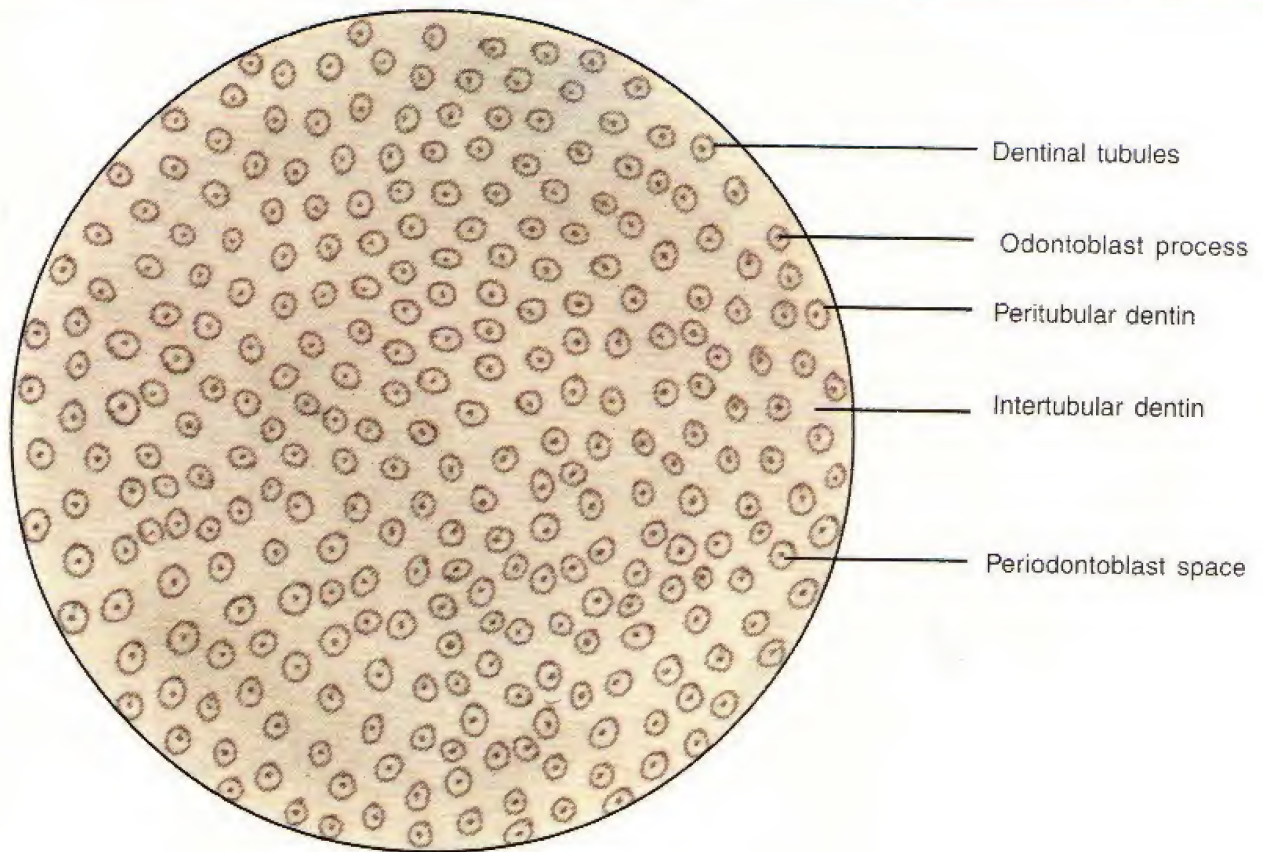


Fig.5.3 Transverse section of dentin

Dentinoenamel junction (Fig. 5.4)

DEJ is scalloped with the convexity facing the dentin. This scalloped shape increases the adherence between enamel and dentin and also helps to prevent shearing of enamel during function.



Identification Points Fig. No. 5.4

DENTINOENAMEL JUNCTION

- Scalloped with convexity facing dentin
- Increases adherence between enamel & dentin.
- Prevents shearing of enamel

rhythmic deposition is indicated by incremental lines. The incremental lines of dentin are called 'lines of von Ebner' which run perpendicular to the dentinal tubules. The distance between these incremental lines are 4 -6 microns and much less in radicular dentin. Sometimes due to disturbance in either matrix deposition or mineralization these incremental lines may become accentuated and are called 'contour lines of Owen'. The



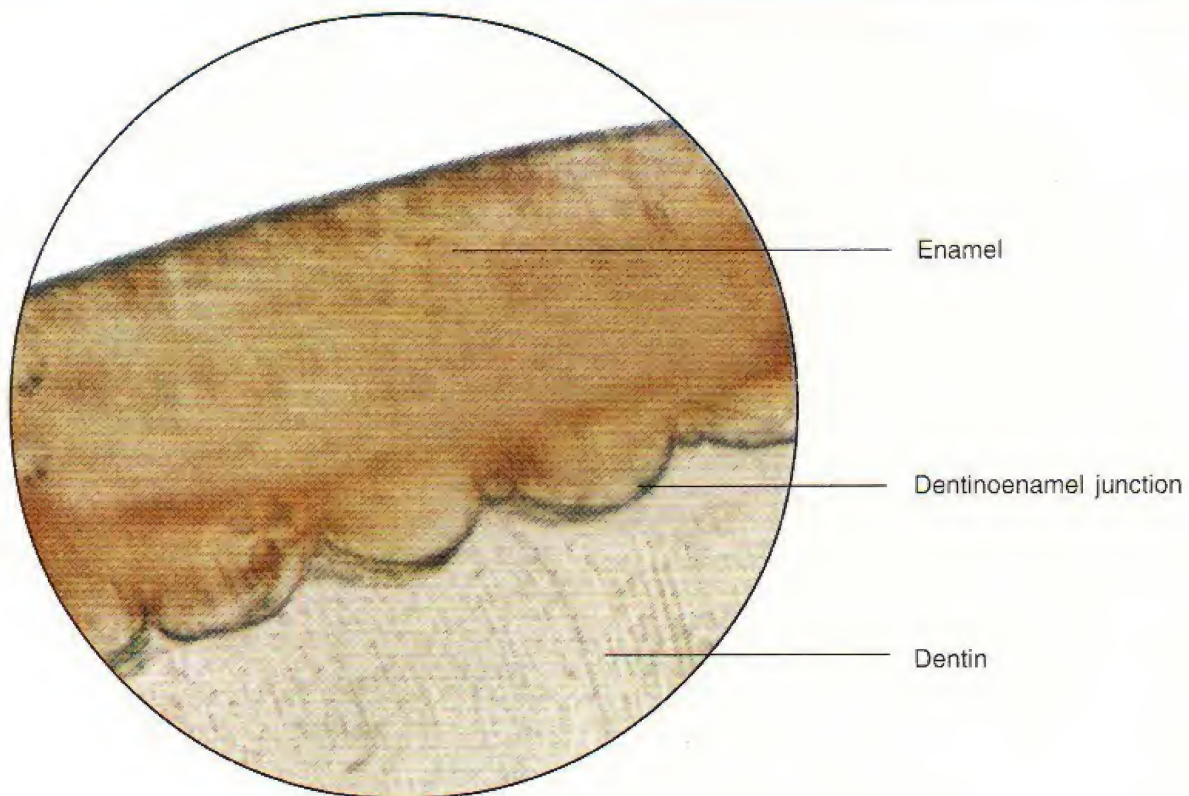
Identification Points Fig. No. 5.5

INCREMENTAL LINES OF DENTIN

- Incremental lines run perpendicular to the dentinal tubules
- Lines of von Ebner represent the rhythmic deposition
- Contour lines of Owen are accentuated incremental lines

Incremental lines of dentin (Fig. 5.5)

Formation of dentin is a rhythmic process with alternating phases of activity and quiescence. This



Dentinoenamel junction (Photomicrograph 4X)

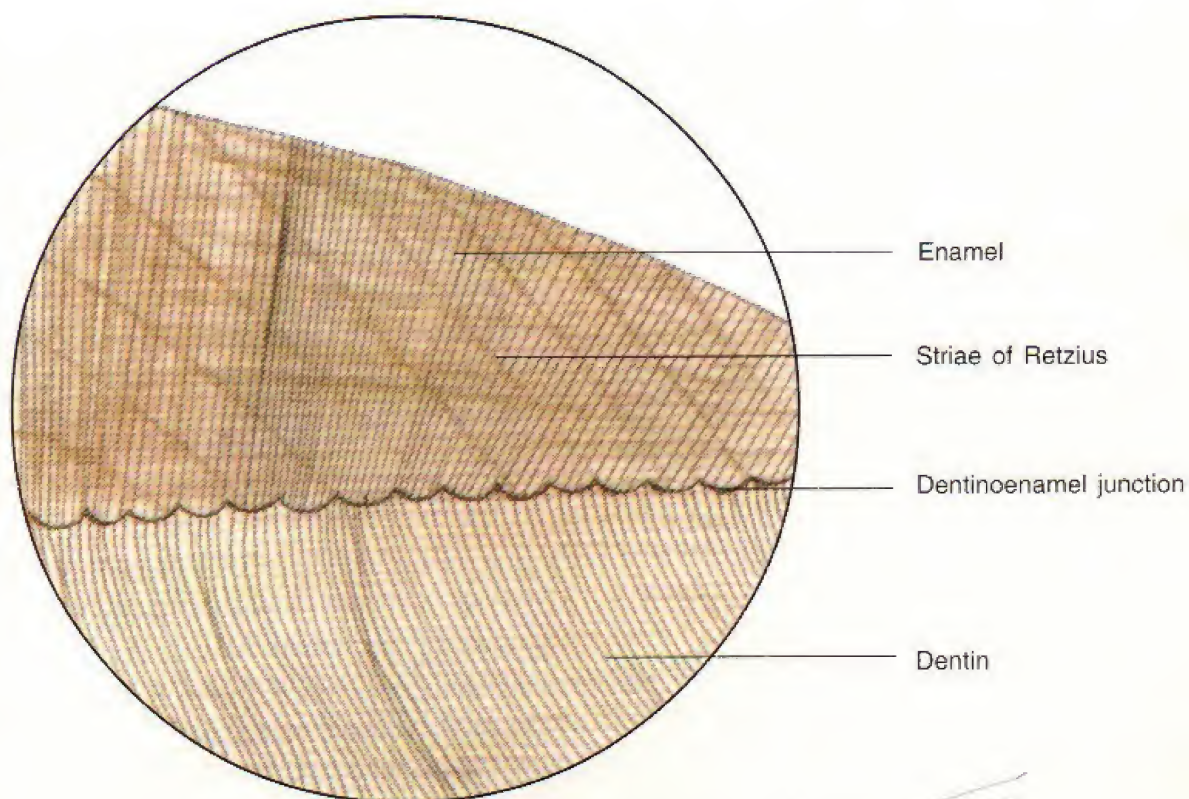


Fig. 5.4 Dentinoenamel junction

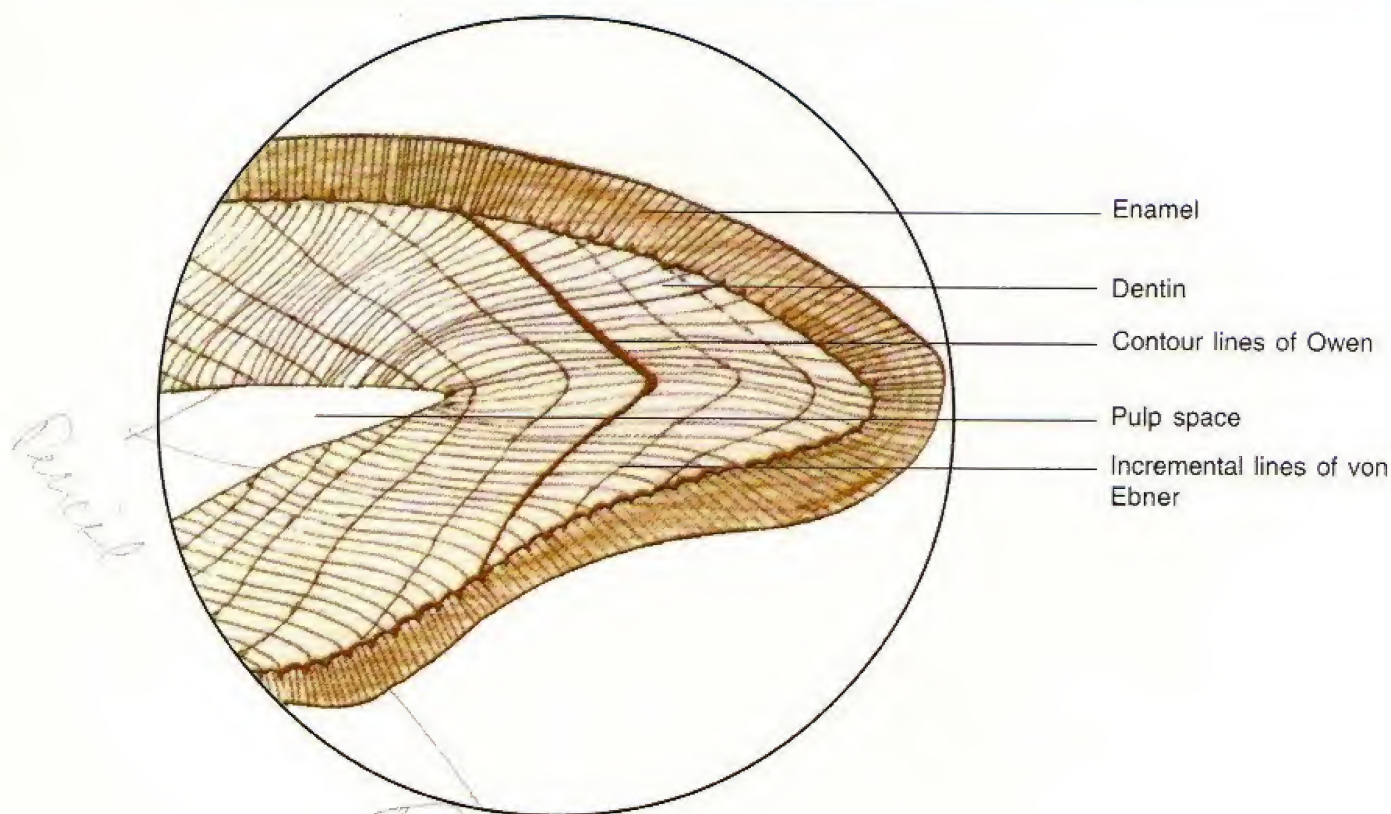


Fig.5.5 Incremental lines of dentin

accentuated incremental line formed due to the change in environment at the time of birth is called neonatal line, and this line separates prenatal dentin from postnatal dentin.

Interglobular dentin (Fig. 5.6)

Interglobular dentin is a hypocalcified area seen in coronal circumpulpal dentin immediately below mantle dentin. These areas appear slightly dark in a ground section under transmitted light. Dentin calcification occurs in the form of globules. Failures of fusion of these globules into a homogenous mass result in the formation of interglobular dentin. They appear star shaped with curved outline of adjacent globules. The dentinal tubules pass uninterruptedly through interglobular dentin suggesting that this area results from defect in mineralization, and not matrix deposition.



Identification Points Fig. No. 5.6

INTERGLOBULAR DENTIN

- Hypocalcified structure of dentin
- Appear as star shaped structure in circumpulpal dentin.
- Develop due to lack of fusion of globules of mineralization.

Granular layer of Tomes (Fig. 5.7)

It is a structure seen only in radicular dentin adjacent to cementodentinal junction. This layer appears in a ground section as dark granular structure, gradually increasing in thickness from CEJ till the apex. Tomes granular layer is thought to be formed because of looping and coalescing of dentinal tubules near the dentinocemental junction.

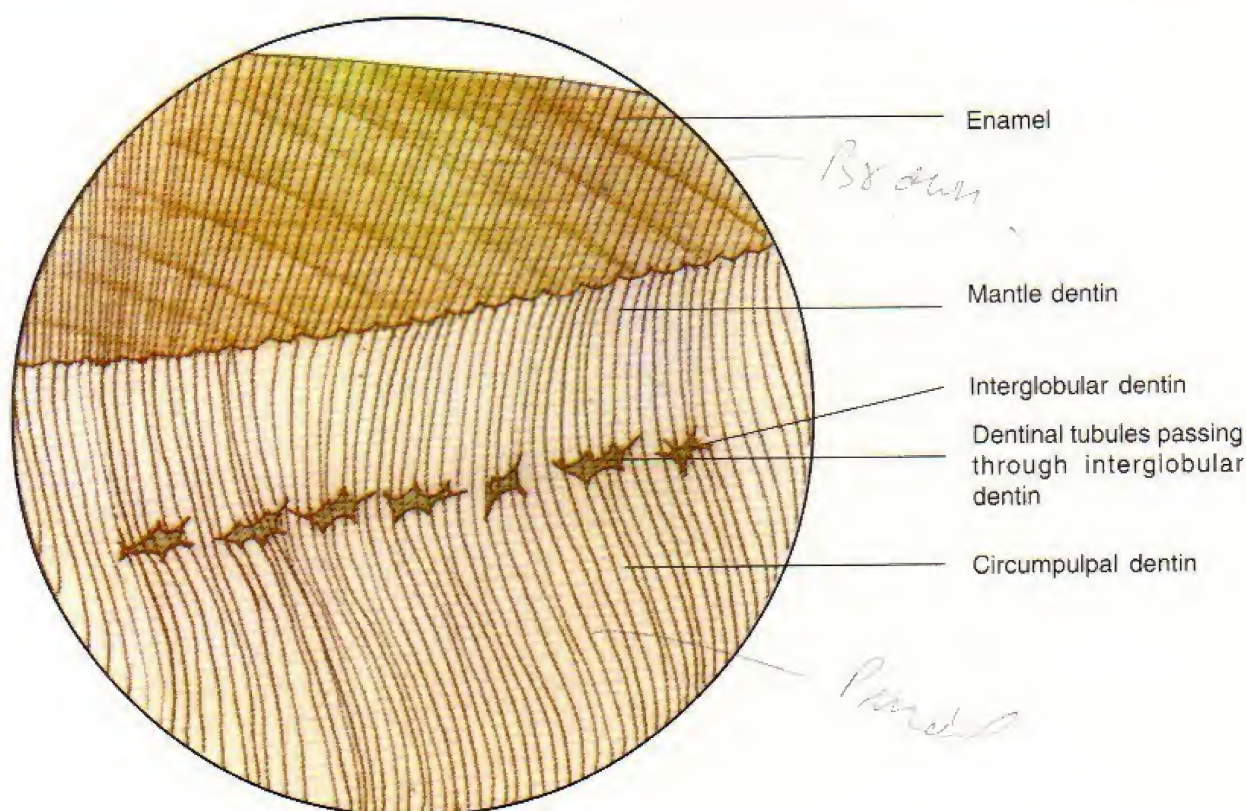


Fig. 5.6 Interglobular dentin

KEY

Identification Points Fig. No. 5.7



GRANULAR LAYER OF TOMES

- Seen in radicular dentin adjacent to DCJ
- Appear as dark granular structure
- Formed due to looping & coalescing of dentinal tubules.

Dead Tracts (Fig. 5.8)

Dead tracts are empty dentinal tubules those appear dark in ground section of dentin under transmitted light and white under reflected light. These dead tracts are formed due to degeneration of odontoblast processes in the dentinal tubules. This occurs due to exposure of dentin following attrition, abrasion or erosion. These empty

dentinal tubules are filled with air; and hence appear dark under transmitted light. Dead tracts may also develop in the region of cusp or incisal edges due to death of odontoblasts occurring as a result of over crowding. True dead tracts can be identified by the presence of reparative dentin at their pulpal end.

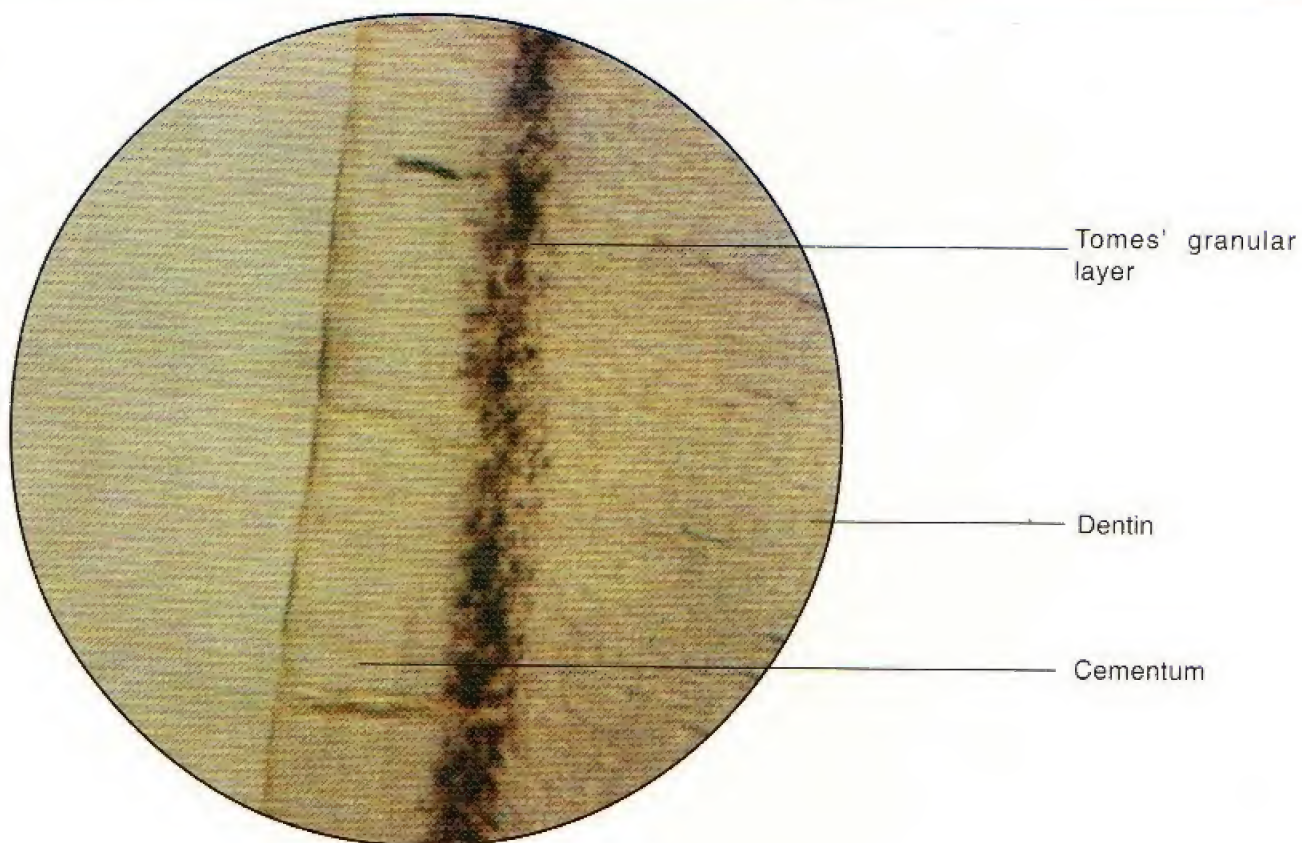
KEY

Identification Points Fig. No. 5.8



DEAD TRACTS

- Appear dark under transmitted light & white under reflected light.
- Formed due to degeneration of odontoblast processes in the tubules
- Presence of reparative dentin at the pupal end of dead tracts.



Tomes' granular layer (Photomicrograph 10X)

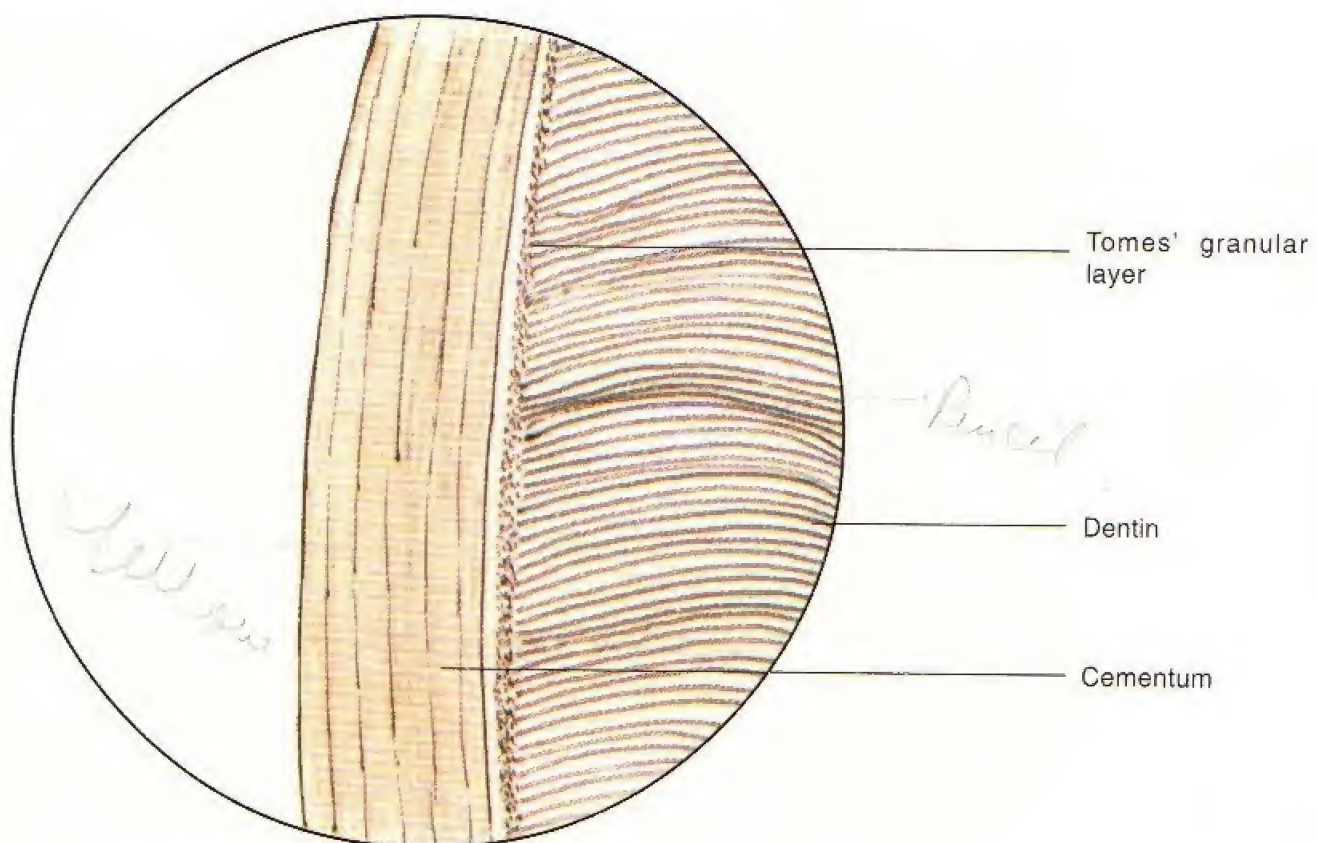
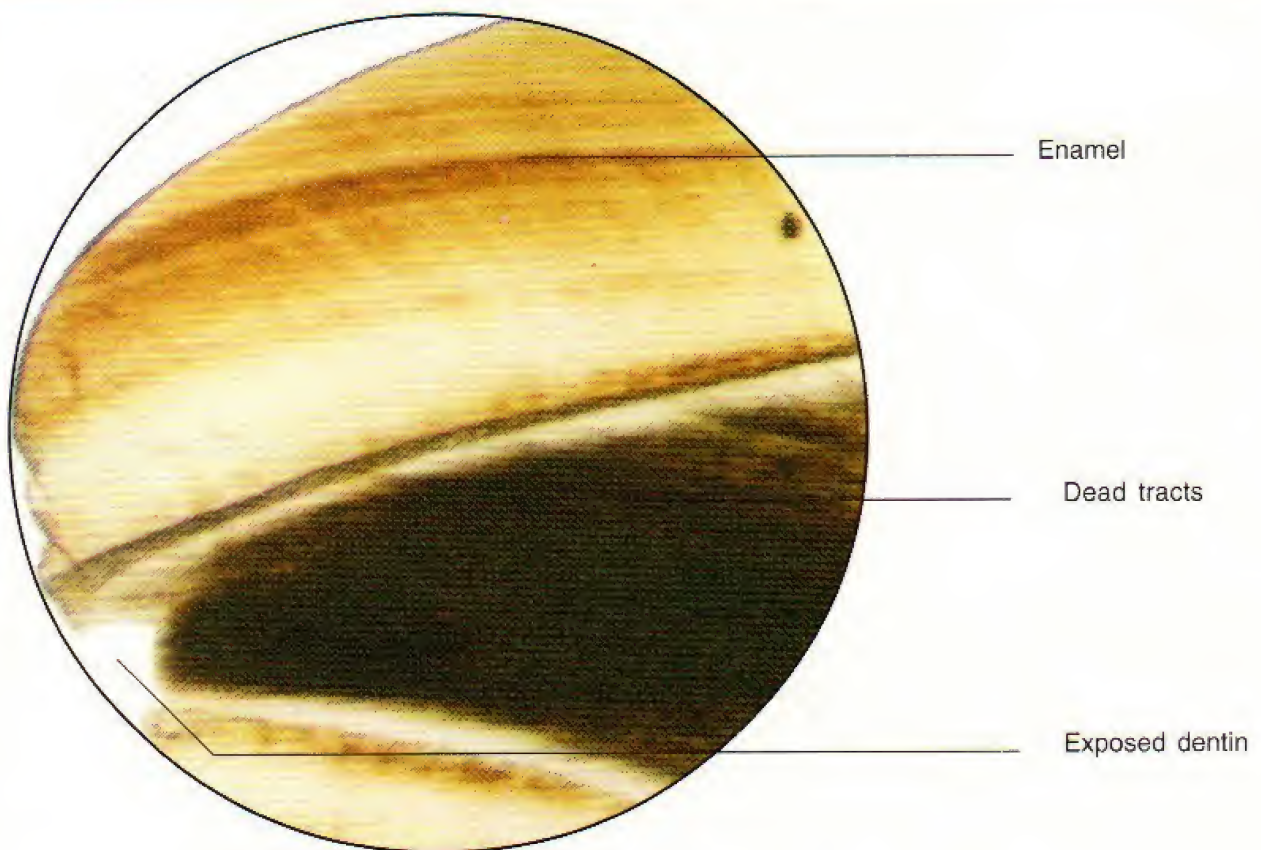


Fig.5.7 Tomes' granular layer



Dead tracts (Photomicrograph 4X)

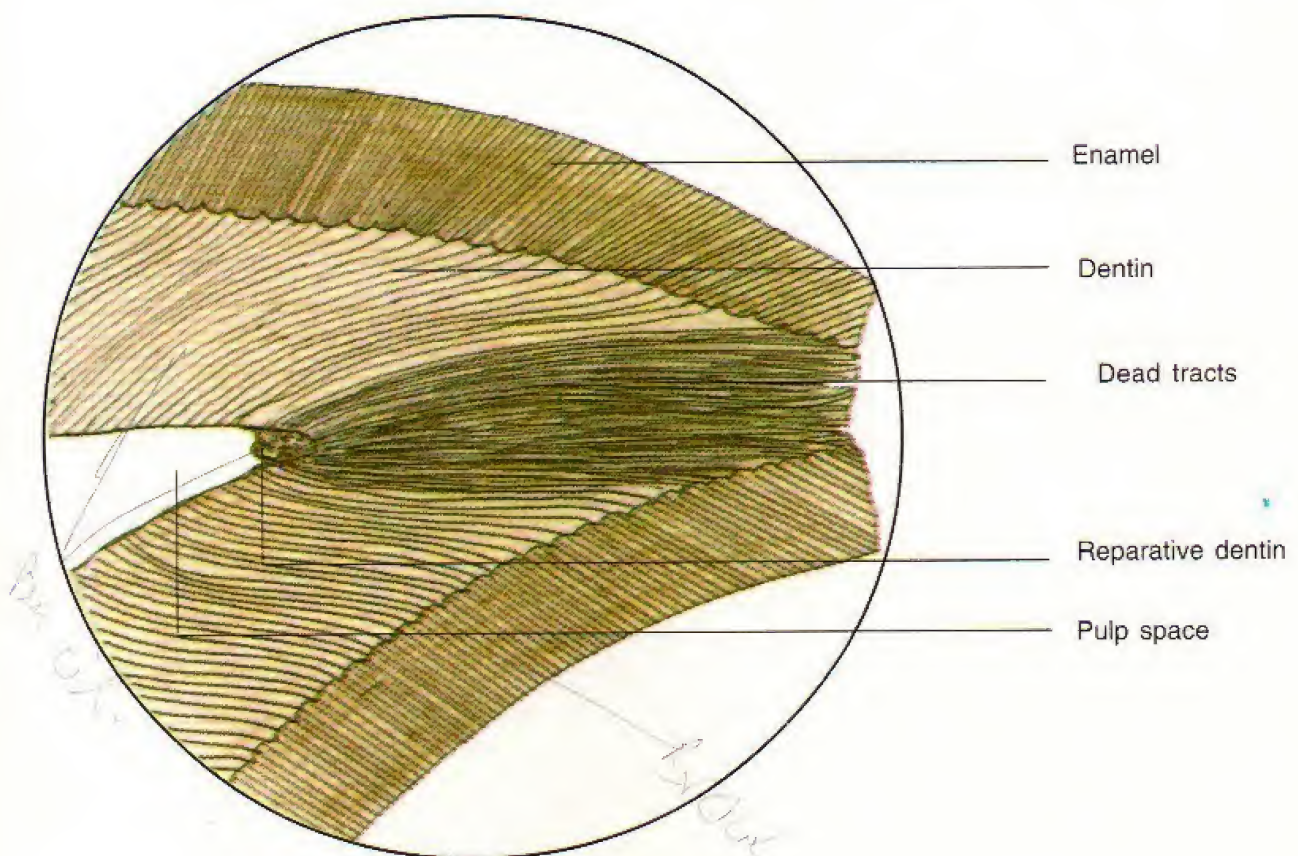


Fig.5.8 Dead tracts

6

Pulp

- Histology of pulp
- Pulp stones

Pulp is the soft tissue component of the tooth that is situated in the pulpal cavity located at the center of the tooth. Pulp is basically a connective tissue that contains formative cells of dentin, defense cells for protection, undifferentiated mesenchymal cells, and also blood vessels and nerves. Since the pulp is a soft tissue enclosed within calcified components, the structure can be studied only with the help of decalcified sections.

HISTOLOGY OF NORMAL PULP (Fig. 6.1)

In the pulp **four** distinct zones are seen microscopically.

Odontoblastic zone: This is the most peripheral zone of pulp seen adjacent to the predentin layer. Odontoblast cells are columnar in the crown and flattened in the root. They have process at their apical portion extending into the dentinal tubules. Cells in the coronal pulp shows a pseudostratified arrangement due to cell crowding.



Identification Points Fig. No. 6.1

PULP

- Four zones are seen
- Zones are odontoblast zone, cell free zone, cell rich zone and pulp core.
- Pulp core contains large vessels and nerves.

Cell free zone: Beneath the odontoblast layer is cell free zone of Weil which is devoid of cells, but has fibers and nerves.

Cell rich zone: This zone is seen beneath the cell free zone and is rich in cells. The cells present are mainly fibroblasts and progenitor cells.

Pulp core: The central portion of pulp is called pulp core that contains cells, large blood vessels and nerves etc. distributed in the ground substance.

PULP STONES (Fig. 6.2)

Pulp stones are calcifications seen in the pulp. They can be true or false depending on structure. True pulp stones have a tubular structure resembling dentin while false pulp stones are

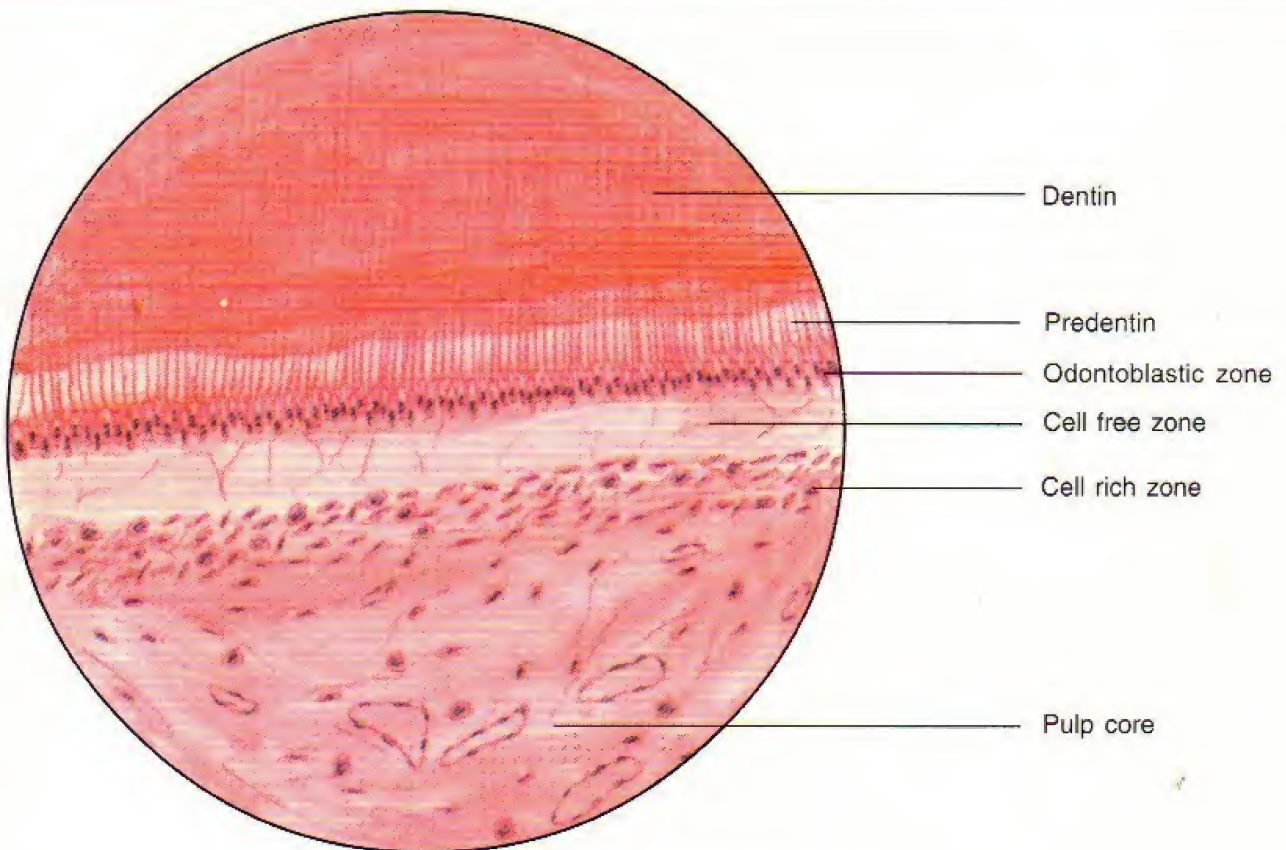


Fig. 6.1 Histology of Pulp

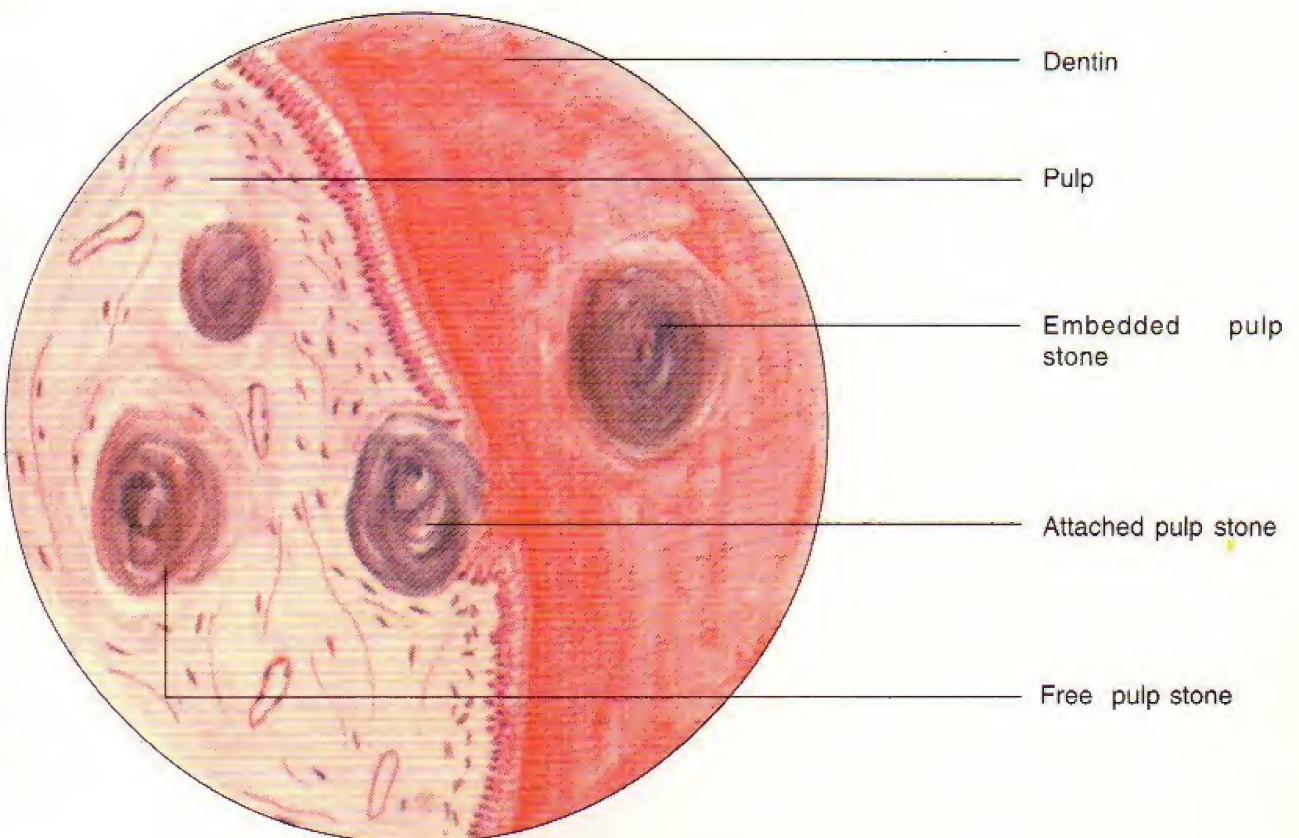


Fig. 6.2 Pulp Stones

concentric rings of calcified material not resembling dentin. Pulp stones are also classified in to -

1. **Free pulp stones** – lying free in the pulp without being attached to the dentin.
2. **Attached pulp stones** – these are attached to the dentin.
3. **Embedded pulp stones** – when pulp stones are completely surrounded by dentin.

**Identification Points Fig. No. 6.2****PULP STONES**

- Calcifications seen in pulp.
- May be true or false pulp stones
- Can be free, attached or embedded.

Cementum

- Structure of cementum
 - Cellular cementum
 - Acellular cementum
- Cementoenamel junctions

Cementum is a calcified structure that forms the outer covering of the root of the tooth. Cementum forms a part of attachment apparatus in to which periodontal ligament is inserted to hold the tooth in the alveolar socket. The structure of cementum can be studied using a ground sections or decalcified sections.

STRUCTURE OF CEMENTUM

Based on histological structure cementum is classified in to **acellular and cellular** cementum.

Cellular cementum (Fig. 7.1)

Cellular cementum is the cementum in which cementocytes are entrapped, In a ground section of cellular cementum, cementocytes can be easily identified as spider shaped cells, These cells have a cell body and numerous processes or canaliculi radiating from it. The canaliculi are directed

towards the periodontal ligament which is the source of nutrition. Sharpey's fibers are the inserted portion of the periodontal ligament and are seen as black faint lines at an angle to the root surface. Incremental lines of Salter appear as dark lines parallel to root surface. Cellular cementum is located at apical one third of roots and the furcation areas of multi rooted teeth.



Identification Points Fig. No. 7.1

CELLULAR CEMENTUM

- Entrapped cementocytes are seen
- Cementocytes are spider shaped with canaliculi directed to the periodontal ligament.
- Located at the apical one third.

Acellular cementum (Fig. 7.2)

Acellular cementum is the type of cementum that do not contain any cells. In a ground section under transmitted light acellular cementum is seen as a structureless layer. Incremental lines of cementum referred to as lines of Salter are seen as dark lines parallel to the root surface representing rhythmic deposition of cementum. Sharpey's fibers are not distinct because they



Cellular cementum (Photomicrograph 10X)

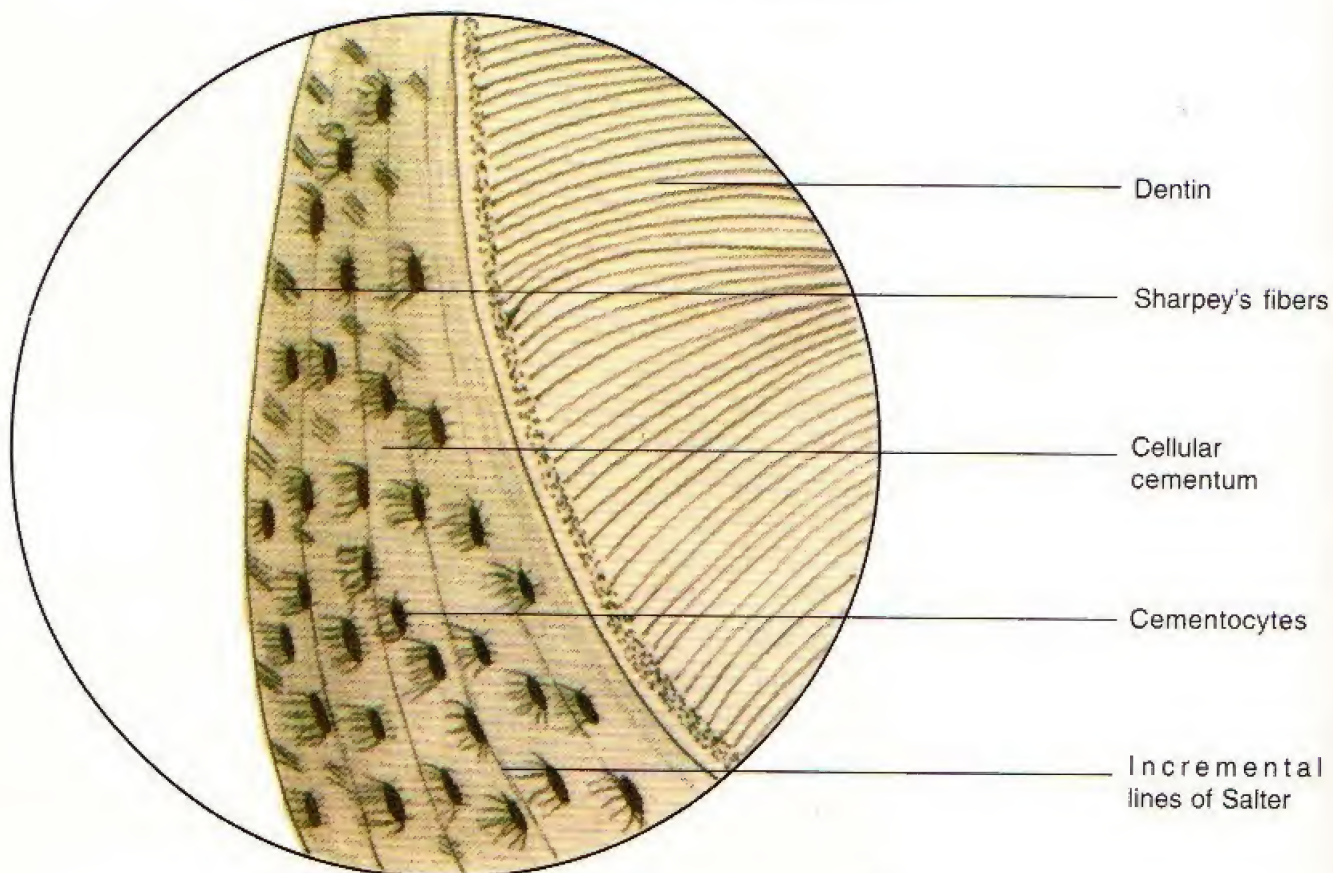
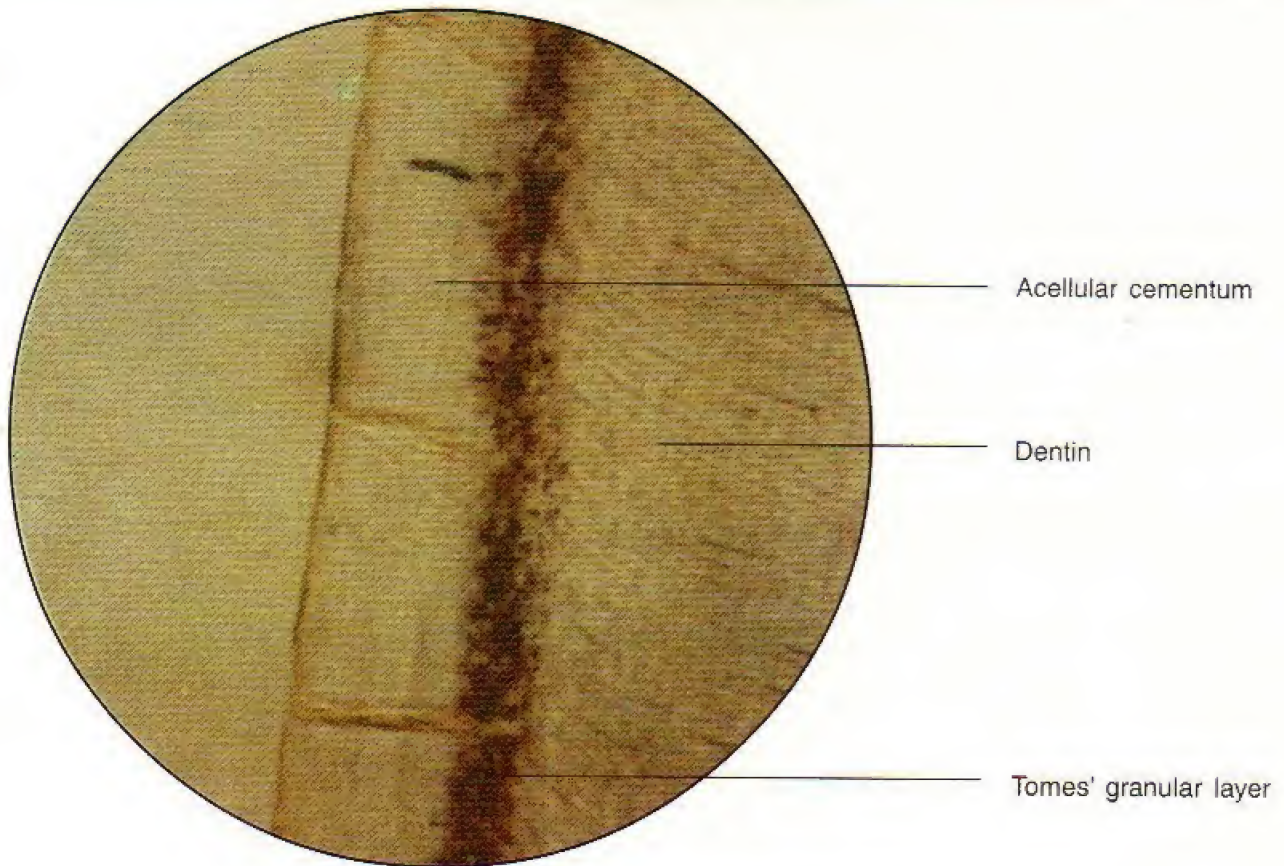


Fig.7.1 Cellular cementum



Acellular cementum (Photomicrograph 10X)

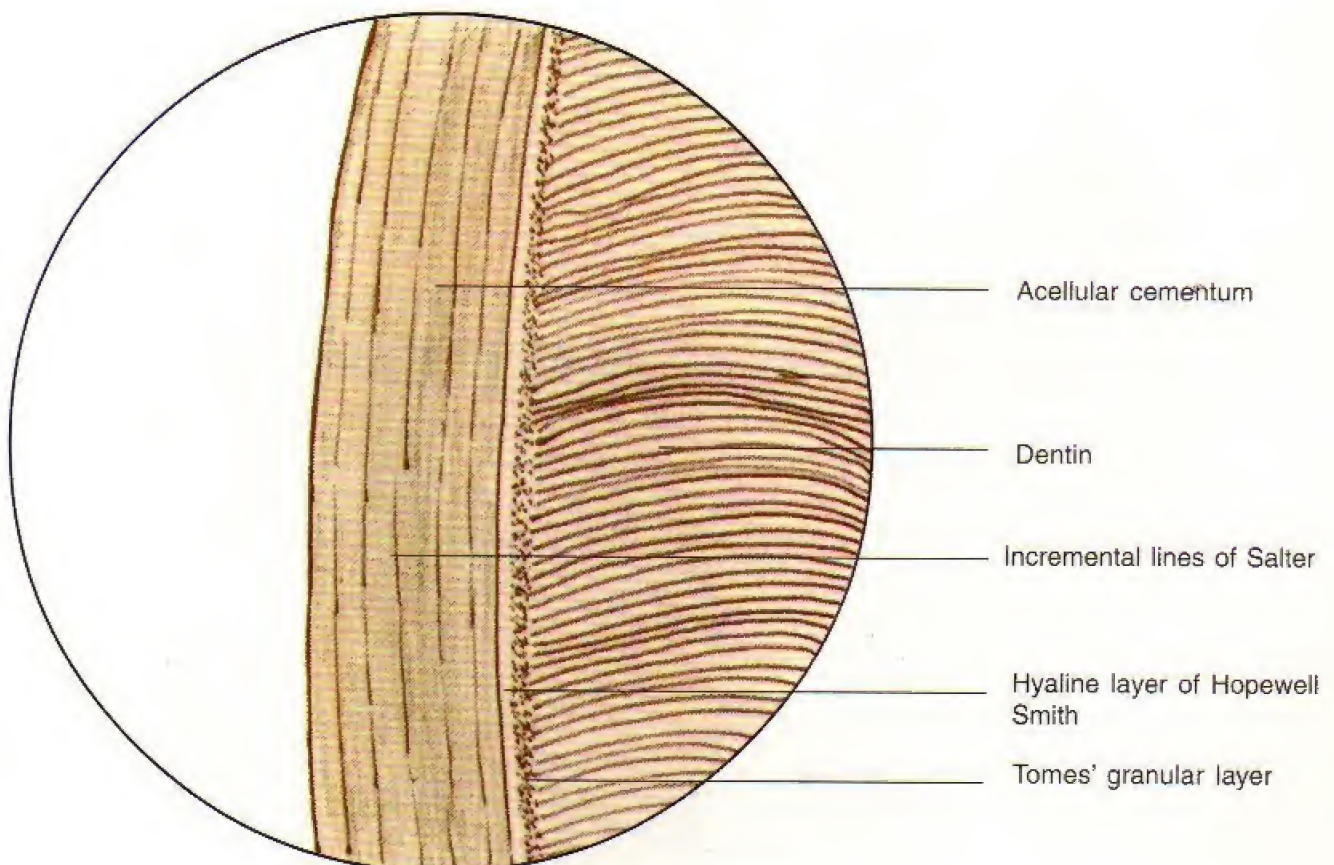


Fig.7.2 Acellular cementum

**Identification Points Fig. No. 7.2****ACELLULAR CEMENTUM**

- Appear as structureless layer
- No entrapped cells
- Located at the cervical two third.

are fully mineralized. Acellular cementum is generally located at the cervical 2/3 of the root.

CEMENTOENAMEL JUNCTIONS

Cementoenamel junction (**CEJ**) is the junction between enamel and cementum that occur at cervical region of tooth.

There are three types of CEJs

Sharp junction (Fig. 7.3)

Enamel and cementum meet edge to edge. This type of junction is seen in 30 % of teeth.

**Identification Points Fig. No. 7.3****CEMENTOENAMEL JUNCTION - SHARP**

- Cementum and enamel meet at sharp point
- Seen in 30% of teeth

Gap type (Fig. 7.4)

In this type there is no junction, instead a zone of root devoid of cementum is seen. This occurs due to lack of degeneration of Hertwig's epithelial root sheath preventing the differentiation of cementoblasts and therefore cementum

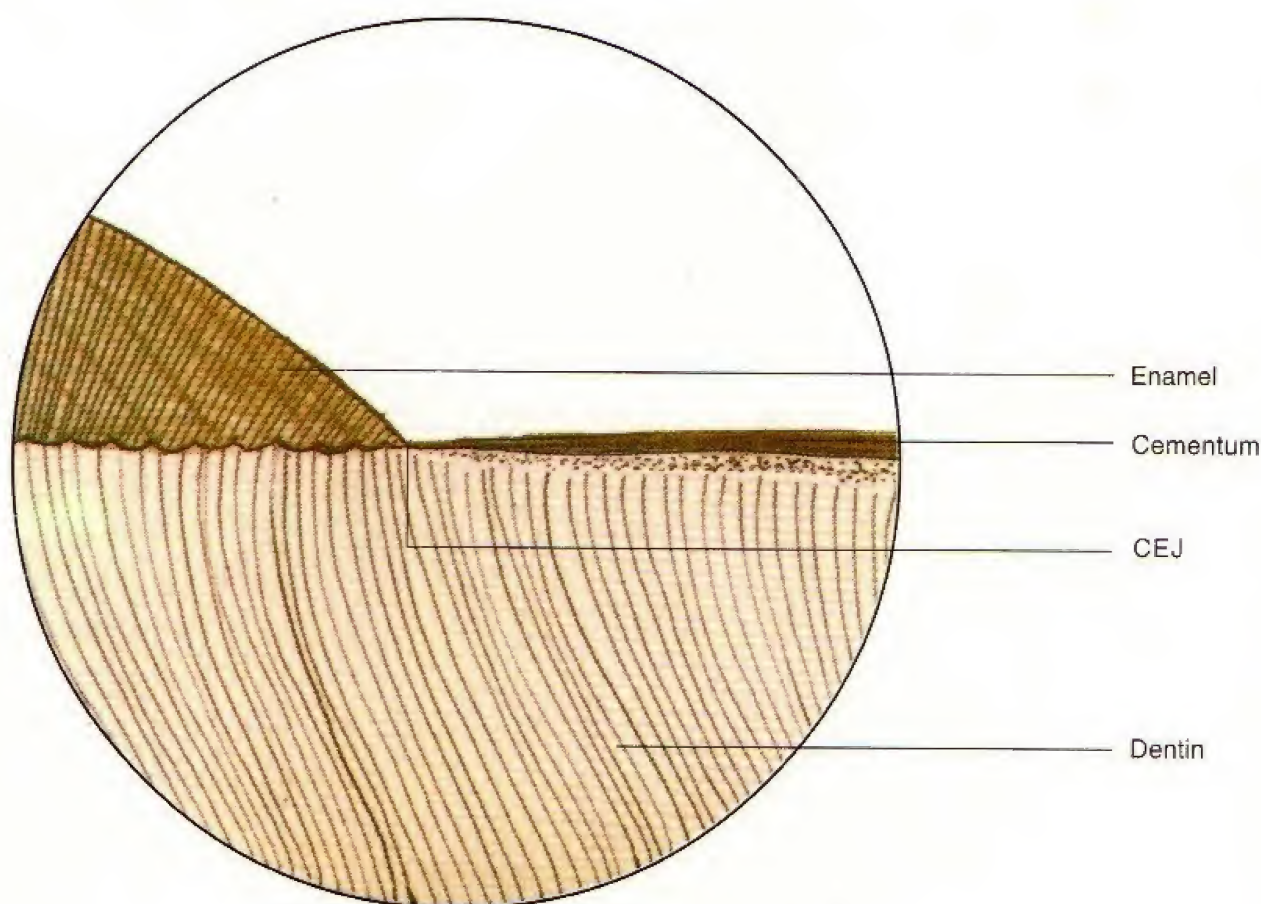


Fig.7.3 Cementoenamel junction - Sharp junction

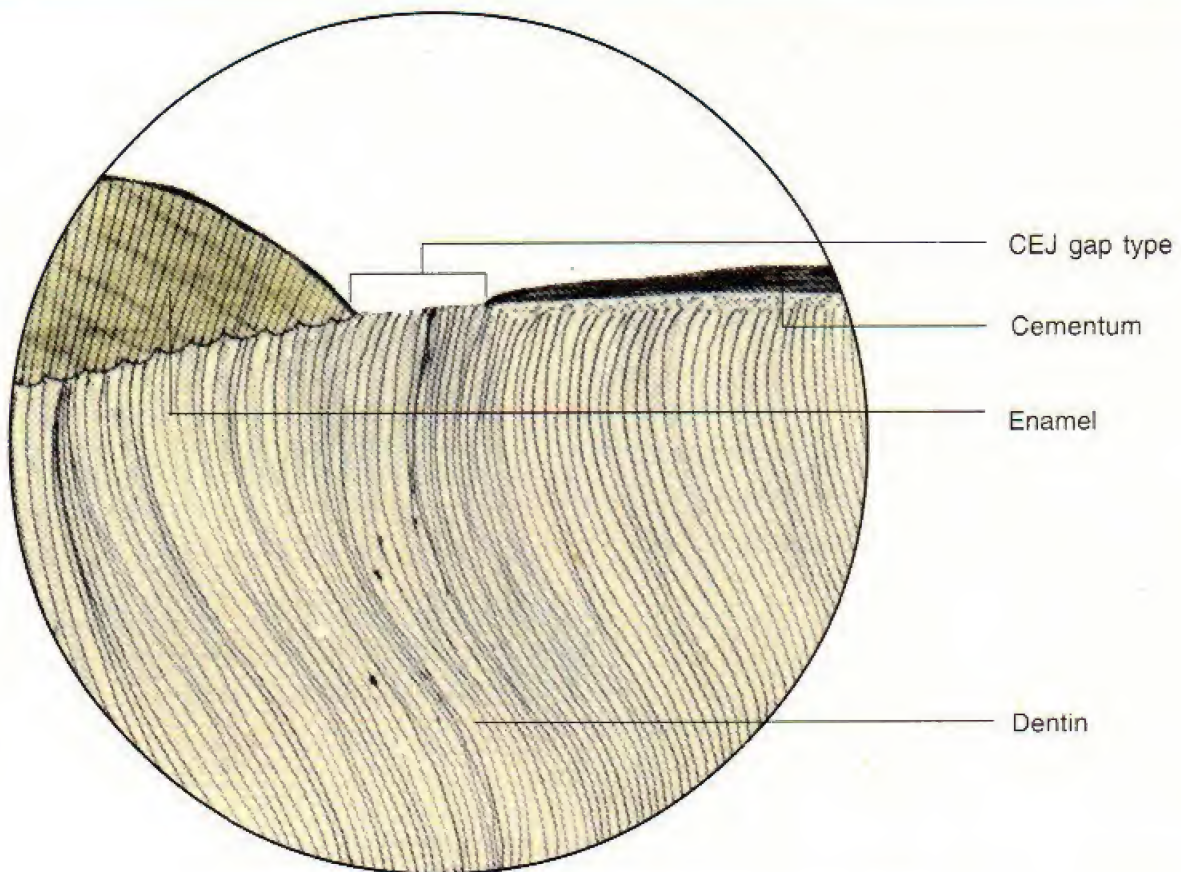


Fig.7.4 Cementoenamel junction - Gap type

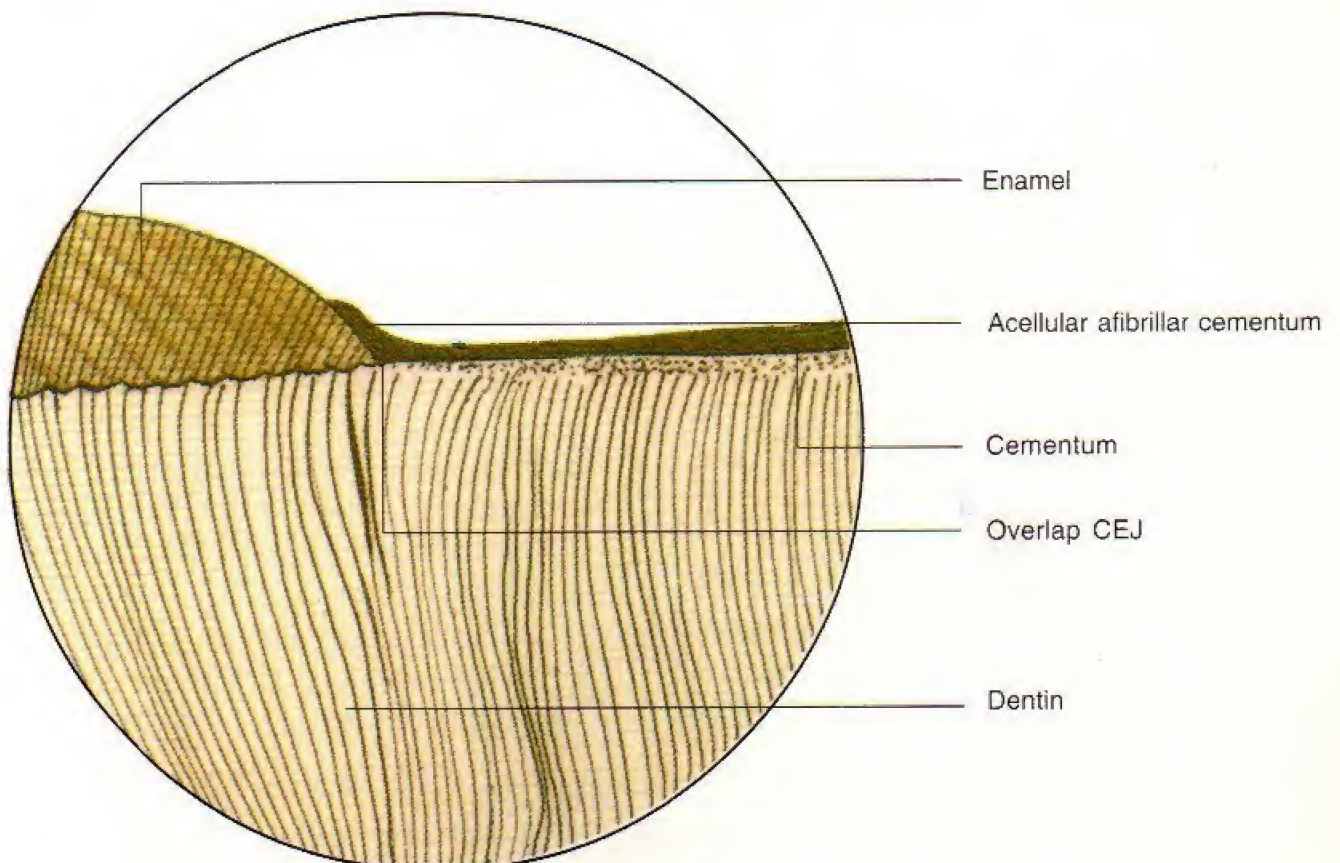


Fig.7.5 Cementoenamel junction - overlap type

KEY**Identification Points Fig. No. 7.4****CEMENTOENAMEL JUNCTION - GAP**

- A gap is present between enamel & cementum
- Occur due to lack of degeneration of HERS
- Seen in 15% of teeth

formation. In this type of junction a portion of radicular dentin is exposed causing sensitivity if root is exposed due to gingival recession. This type is seen in 15% of teeth.

Overlap type (Fig. 7.5)

Cementum overlaps the cervical region of enamel in this type of cements enamel junction. The type

of cementum seen overlapping enamel is acellular afibrillar cementum. This occurs due to degeneration of reduced enamel epithelium which allows the dental follicle cells to come in contact with newly formed enamel. Then these cells differentiate in to cementoblasts and lay down cementum. This type of junction is seen in 60% of teeth.

KEY**Identification Points Fig. No. 7.5****CEMENTOENAMEL JUNCTION - OVERLAP**

- Cementum overlap cervical portion of enamel
- Acellular afibrillar cementum is seen in the region of overlap
- Seen in 60% of teeth

8

Periodontal Ligament

- Principal fibers of periodontal ligament
- Gingival group of fibers

Periodontal ligament is a connective tissue structure that attaches the tooth to the alveolar bone. It is a part of attachment apparatus of the tooth. The attachment apparatus of the tooth has two hard tissue components, cementum and alveolar bone and two soft tissue components, periodontal ligament and lamina propria of the gingiva. These four components are together called periodontium

PRINCIPAL FIBERS OF PERIODONTAL LIGAMENT (Fig. 8.1)

Periodontal ligament comprises of bundles of collagen fibers attached to cementum on one side and alveolar socket on the other side. The portion of fibers inserted in to the bone and cementum are called Sharpey's fibers. These groups of fibers, having specific orientation are called principal fibers of periodontal ligament. They are-

- **Alveolar crest group of fibers** – extending from the crest of alveolar bone

to the cervical part of the cementum.

- **Horizontal group** – running horizontally between cementum and alveolar bone and arranged perpendicular to the long axis of the tooth.
- **Oblique group** – are arranged obliquely from cementum to alveolar bone and insertion in cementum is more apical than insertion in bone. These constitute the major group of fibers.
- **Apical group** (Fig. 8.2) – are located in the apical region of the tooth, radiating from the apex of the root to the base of the alveolar socket.
- **Interradicular fibers** – are seen only in multi rooted teeth. These fibers radiate from



Identification Points Fig. No. 8.1 & 8.2

PRINCIPAL FIBERS

- Fiber groups having specific orientation
- Five groups are seen, helping to attach the tooth to alveolar bone.
- Principal fibers are alveolar crestal, horizontal, oblique, apical and inter radicular fibers.

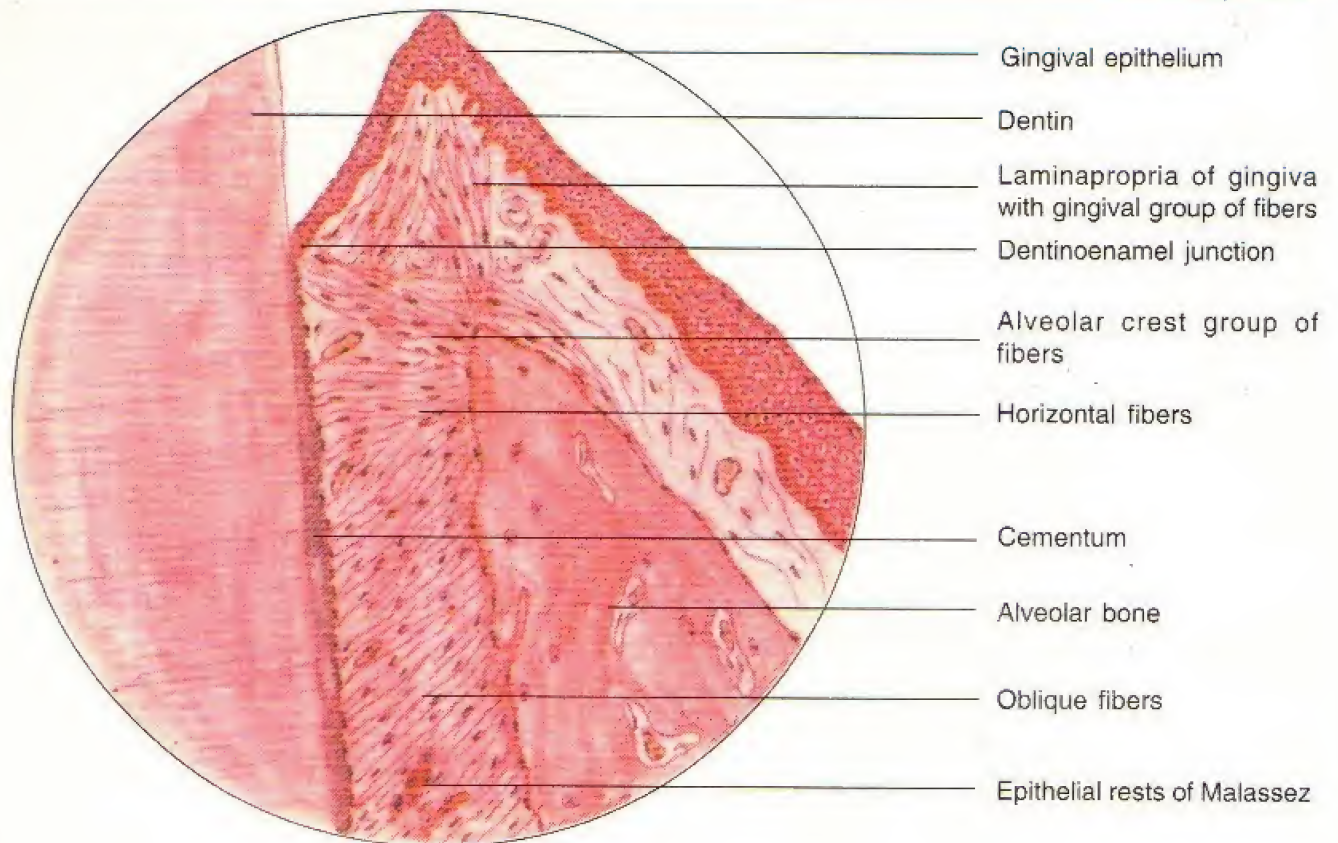


Fig. 8.1 Principal fibers of periodontal ligament

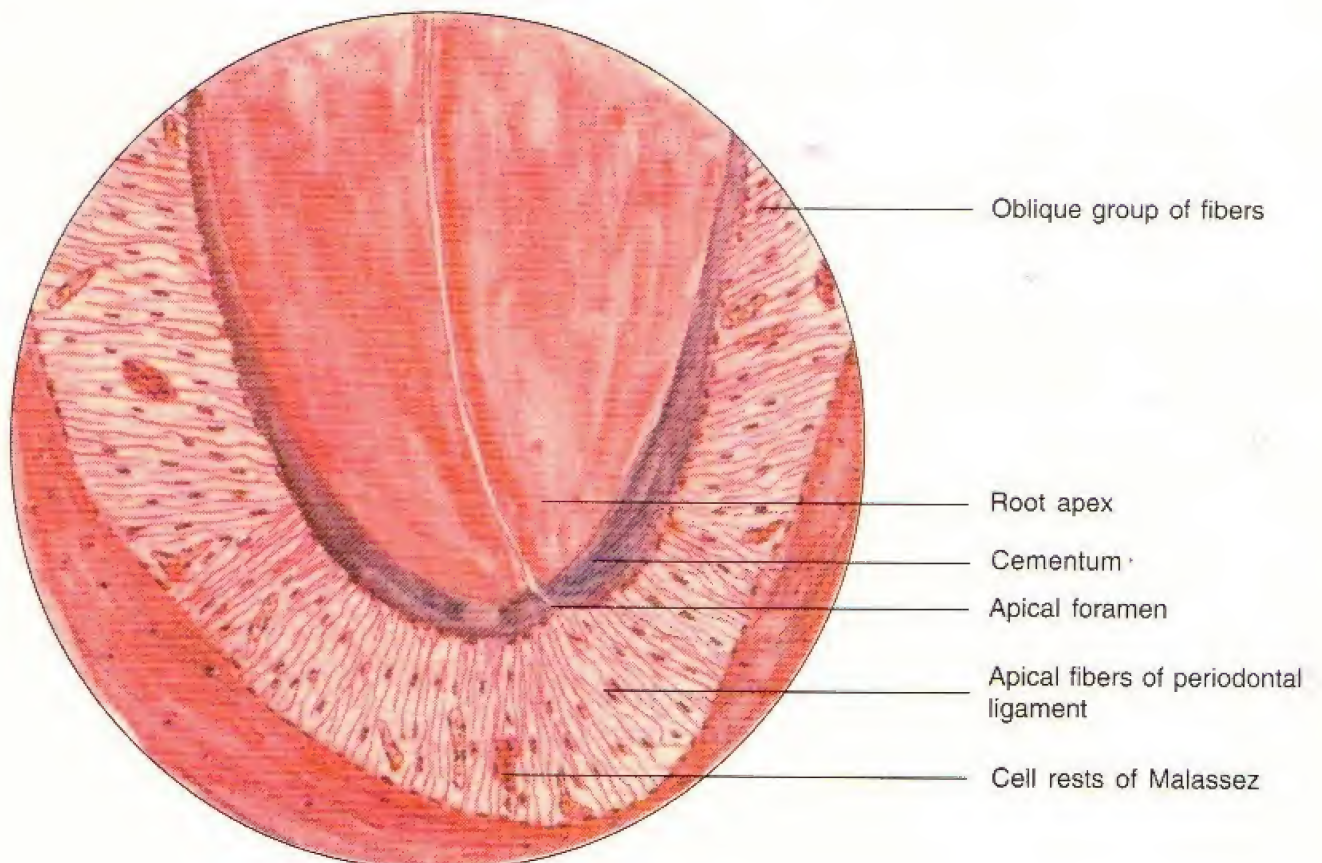


Fig. 8.2 Apical group of fibers

the furcation area to the crest of interradicular septum.

GINGIVAL GROUP OF FIBERS (Fig 8.3)

These are the secondary fibers of periodontal ligament seen in the lamina propria of the gingiva and supplement the principal fibers in maintaining the functional integrity of the teeth. These include-

Dento gingival – extending from the cervical portion of the cementum to the lamina propria of gingiva.

Dento periosteal – extending from cementum to the periosteum of the alveolar crest and of the vestibular and oral surface of the alveolar bone.

Alveologingival — extending from the crest



Identification Points Fig. No. 8.3

GINGIVAL GROUP OF FIBERS

- Are supplementary fibers of periodontal ligament
- Major groups are alveologingival, dentogingival, dentoperiosteal and circular fibers.
- Assist the principal fibers in function.

of the alveolar bone to the lamina propria of gingiva.

Circular fibers – these fibers are arranged in the gingival connective tissue, encircling the tooth like a collar.

Transseptal fibers are also accessory fibers extending interproximally between adjacent teeth.

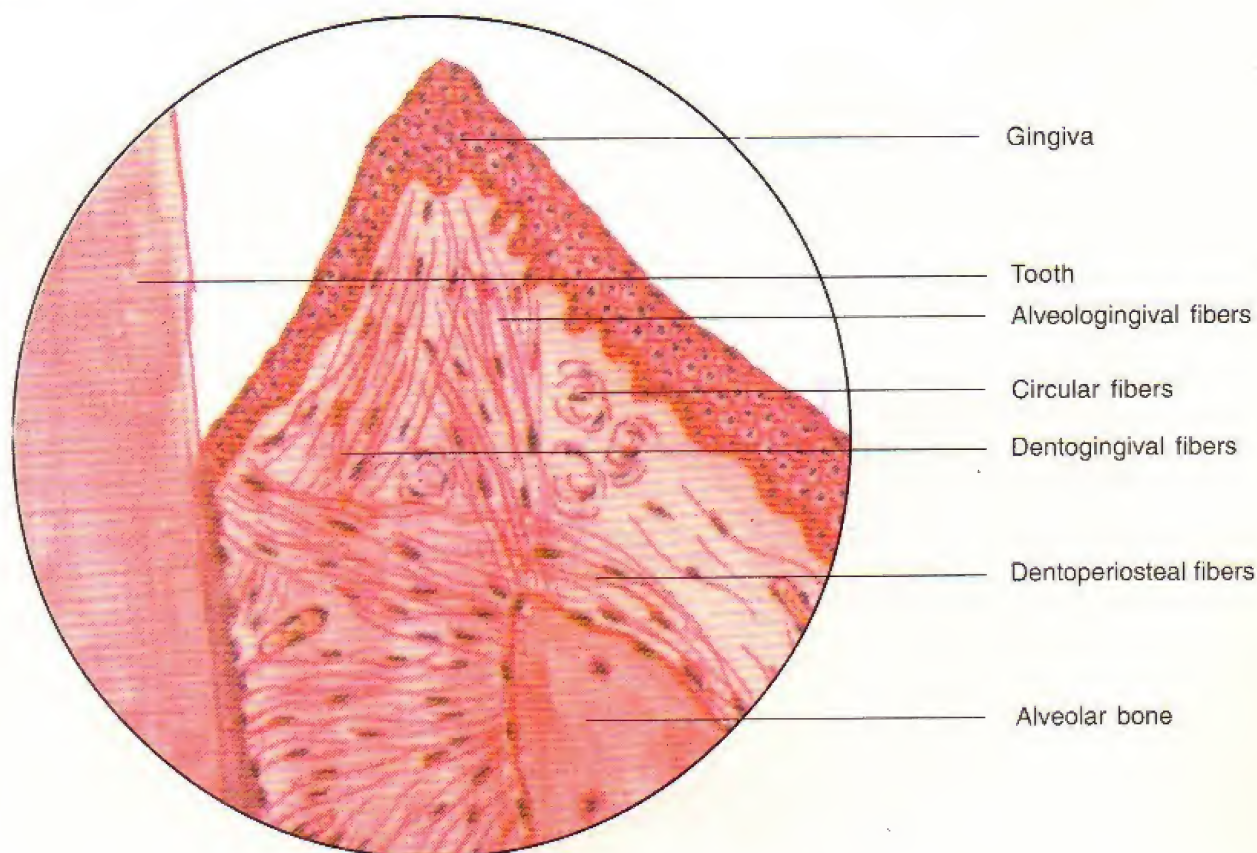


Fig. 8.3 Gingival group of fibers

9

Maxillary Sinus

- Microscopic features

Maxillary sinus is a paranasal sinus located in the body of the maxilla. Maxillary sinus is also called antrum of Highmore.

MICROSCOPIC FEATURES (Fig. 9.1)

Maxillary sinus is lined by pseudo stratified ciliated columnar epithelium. This epithelial layer is mainly composed of ciliated columnar cells. Along with these, there are non ciliated columnar cells, basal cells and goblet cells. Goblet cells are unicellular

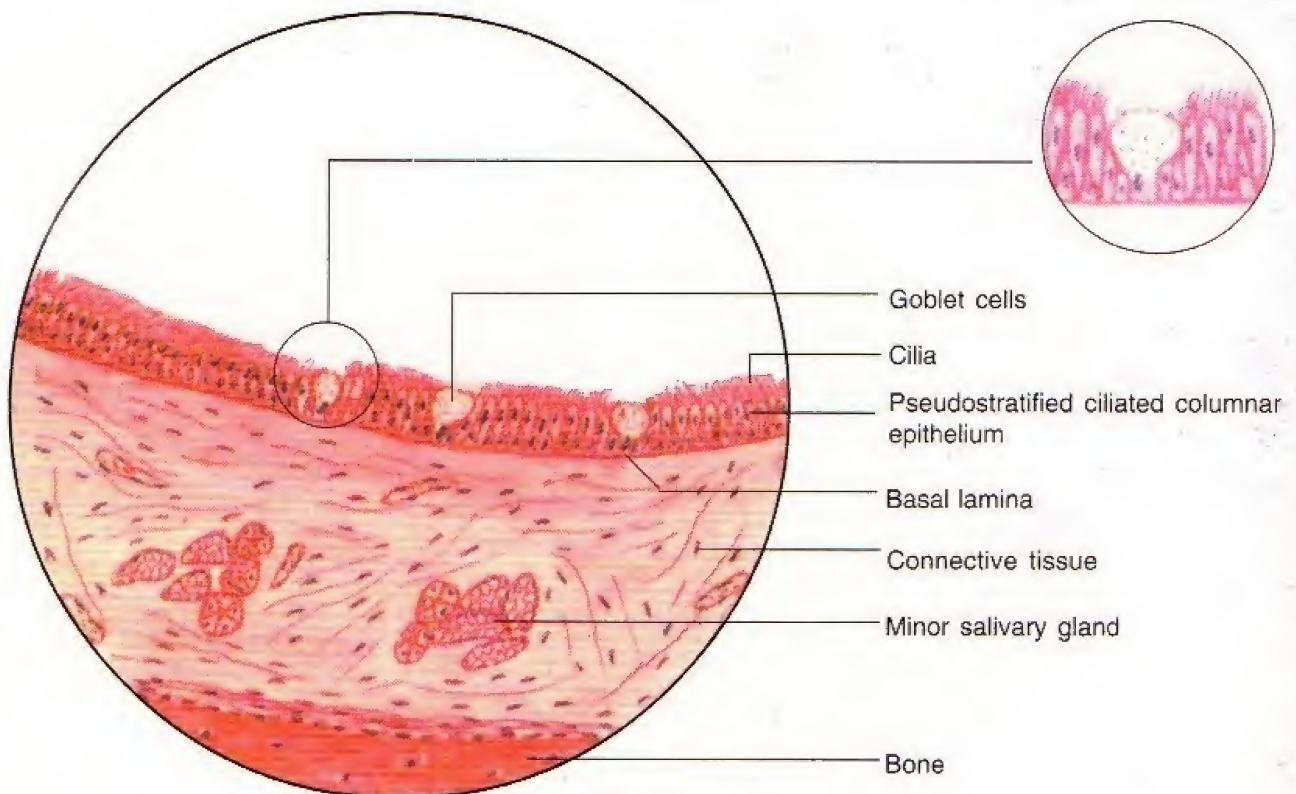


Fig 9.1 Histology of maxillary sinus

secretory organ which are goblet shaped with a basally placed nucleus and apical cytoplasm filled with secretory products. In a hematoxylin and eosin stained section cytoplasm of goblet cells appear empty. Cilia of the lining epithelium help to move the secretions.

This epithelium is separated from sub epithelial connective tissue by a basal lamina. Sub epithelial connective tissue layer has collagen fibers and fibroblasts and also minor salivary glands which include both serous and mucous glands. This layer is attached to the periosteum of the bone of the maxilla.

**Identification Points Fig. No. 9.1****MAXILLARY SINUS**

- Lined by pseudostratified ciliated columnar epithelium.
- Goblet cells are present.
- Connective tissue contains mixed salivary gland.

- Structure of oral mucosa
 - Buccal mucosa
 - Gingiva
 - Hard palate
 - Vermilion border of lip
 - Tongue

STRUCTURE OF ORAL MUCOSA

Oral mucosa is the moist lining of the oral cavity, which is lined by stratified squamous epithelium. The connective tissue beneath is called lamina propria and is composed of collagen fibers, along with the various cells of connective tissue in a ground substance. The interface between epithelium and connective tissue is irregular with projections of epithelium interdigitating with those of connective tissue. The projections of epithelium are called epithelial ridges or rete ridges and of connective tissue are called connective tissue papillae. Epithelium is separated from lamina propria by a distinct basement membrane. Below the mucosa is submucosa containing large vessels and nerves, fat tissue, minor salivary gland and muscle in certain regions of oral mucosa. Based on the histological

structure oral mucosa is classified into keratinized and non keratinized mucosa. Non keratinized mucosa lines the cheek, lip, soft palate, alveolar mucosa, floor of the mouth, ventral aspect of the tongue etc. Keratinized mucosa is seen in gingiva and hard palate.

Buccal mucosa (Non keratinized mucosa) (Fig. 10.1)

Histologically buccal mucosa shows two parts, overlying epithelium and lamina propria. The epithelium is thick and is nonkeratinized stratified squamous. Epithelium has three distinct layers, **Stratum basale**, **Stratum intermedium** and **Stratum superficiale**.

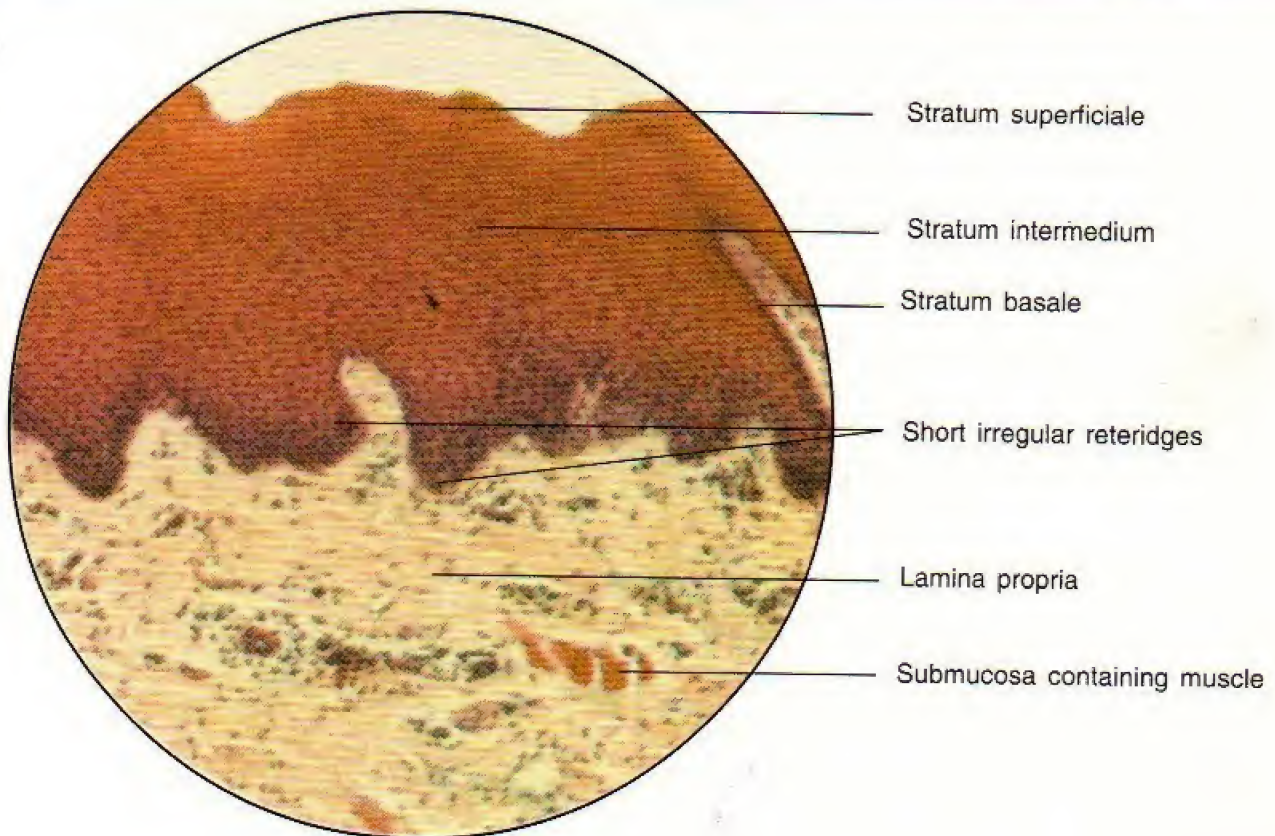
Stratum basale is composed of a single layer of cuboidal cells arranged on basement membrane. Above this a suprabasal layer



Identification Points Fig. No. 10.1

NONKERATINIZED MUCOSA

- Lined by stratified squamous epithelium
- Epithelium has three layers; - stratum basale, stratum intermedium and stratum superficiale.
- Lamina propria merges with sub mucosa.



Buccal Mucosa (Photomicrograph 10X)

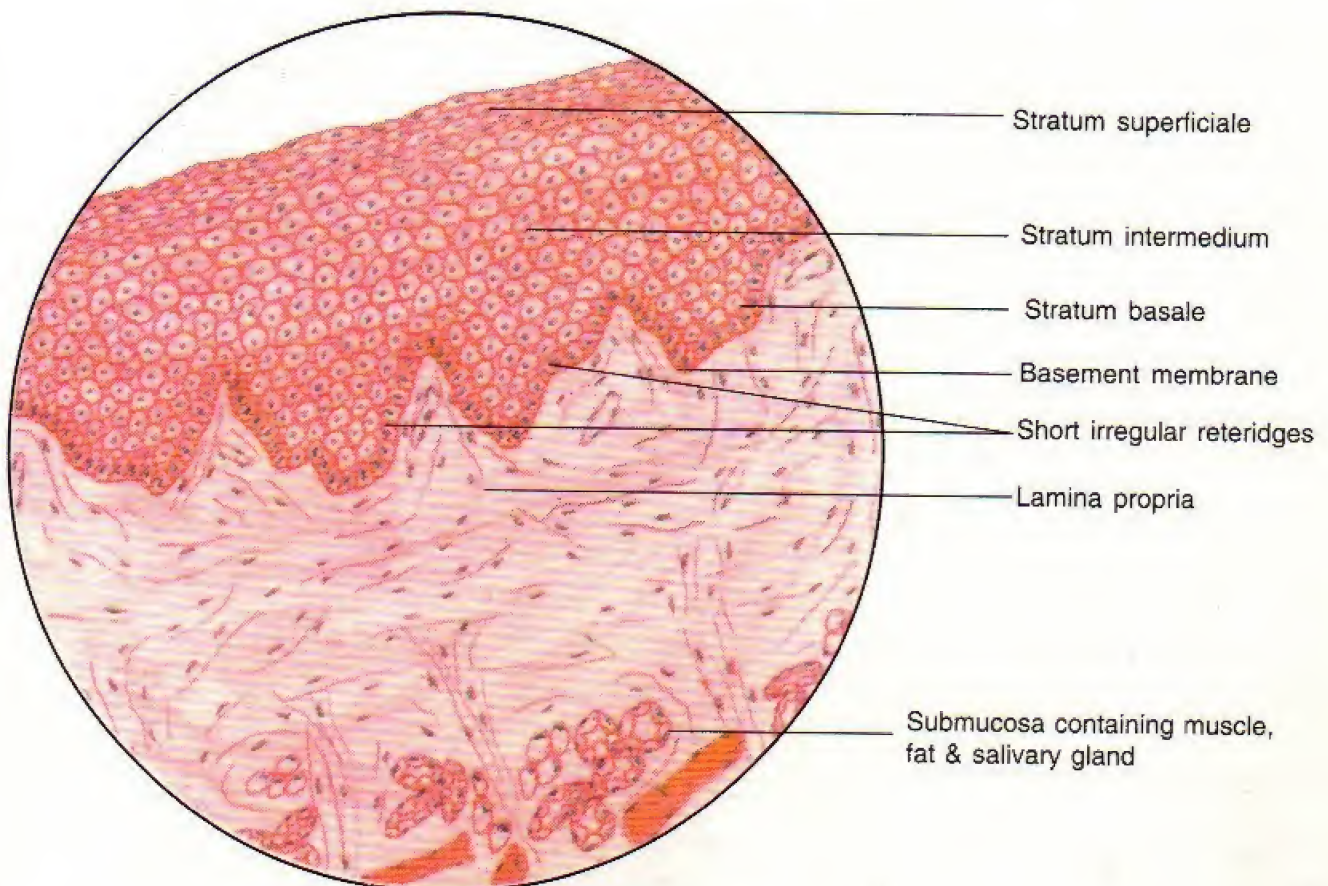


Fig.10.1 Buccal Mucosa

resembling basal layer may be seen. Above the basal layer is stratum intermedium made up of few layers of polyhedral cells with centrally placed nucleus. The stratum superficiale is made up of few layers of flattened cells with flattened nuclei. Epithelial ridges of non keratinized epithelium are short and irregular, interdigitating with connective tissue papillae.

- Lamina propria is less dense compared to keratinized mucosa, and shows collagen fibers fibroblasts and blood vessels.
- The lamina propria of the buccal mucosa merges with underlying submucosa which contain large blood vessels, nerves, fat cells, muscle and minor salivary gland. This submucosa attaches the mucosa to the underlying muscle tissue.

Generally all the nonkeratinized mucosa histologically appear similar to the buccal mucosa except for slight structural variations.

Soft palate is lined by thin nonkeratinized stratified squamous epithelium which may show taste buds. Lamina propria is thick with numerous short papillae. Sub mucosa contains many minor salivary glands.

Ventral surface of the tongue has a thin nonkeratinized epithelial lining. Lamina propria is thin having numerous short papillae. Sub mucosa is thin and irregular with abundant blood vessels. In areas where submucosa is absent mucosa is directly attached to the muscles of the tongue.

Floor of the mouth is lined by very thin nonkeratinized epithelium. Lamina propria shows short papillae and is rich in vascular supply. Submucosa is loose fibrous tissue with fat and minor salivary glands.

In **alveolar mucosa** lining epithelium is thin and nonkeratinized with short rete ridges. Lamina propria has many capillary loops. Submucosa

comprises of loose connective tissue containing minor salivary glands. The submucosa attaches alveolar mucosa to the periosteum of alveolar bone

Keratinized Mucosa – Gingiva (Fig. 10.2)

In a histological section gingiva shows two portion, epithelium and lamina propria.

The overlying epithelium is keratinized and stratified squamous with four distinct layers. The first layer adjacent to the basement membrane is stratum basale composed of a single layer of cuboidal cells with nucleus arranged perpendicular to the basement membrane. The layer above is stratum spinosum or prickly cell layer composed of few layers of polyhedral cells. Cells have a prickly appearance because they shrink while tissue processing retaining the intercellular attachment. The next layer is stratum granulosum made up of few layers of flattened cells, cytoplasm of which contain hematoxyphilic keratohyline granules. The most superficial layer is stratum corneum composed of many layers of flattened cells filled with keratin. These cells are devoid of nucleus and cytoplasmic organelles. Gingival epithelium predominantly shows parakeratinized surface layer which is characterized by the presence of retained pyknotic nucleus in the corneal layer (In case of orthokeratinization nuclei are absent).

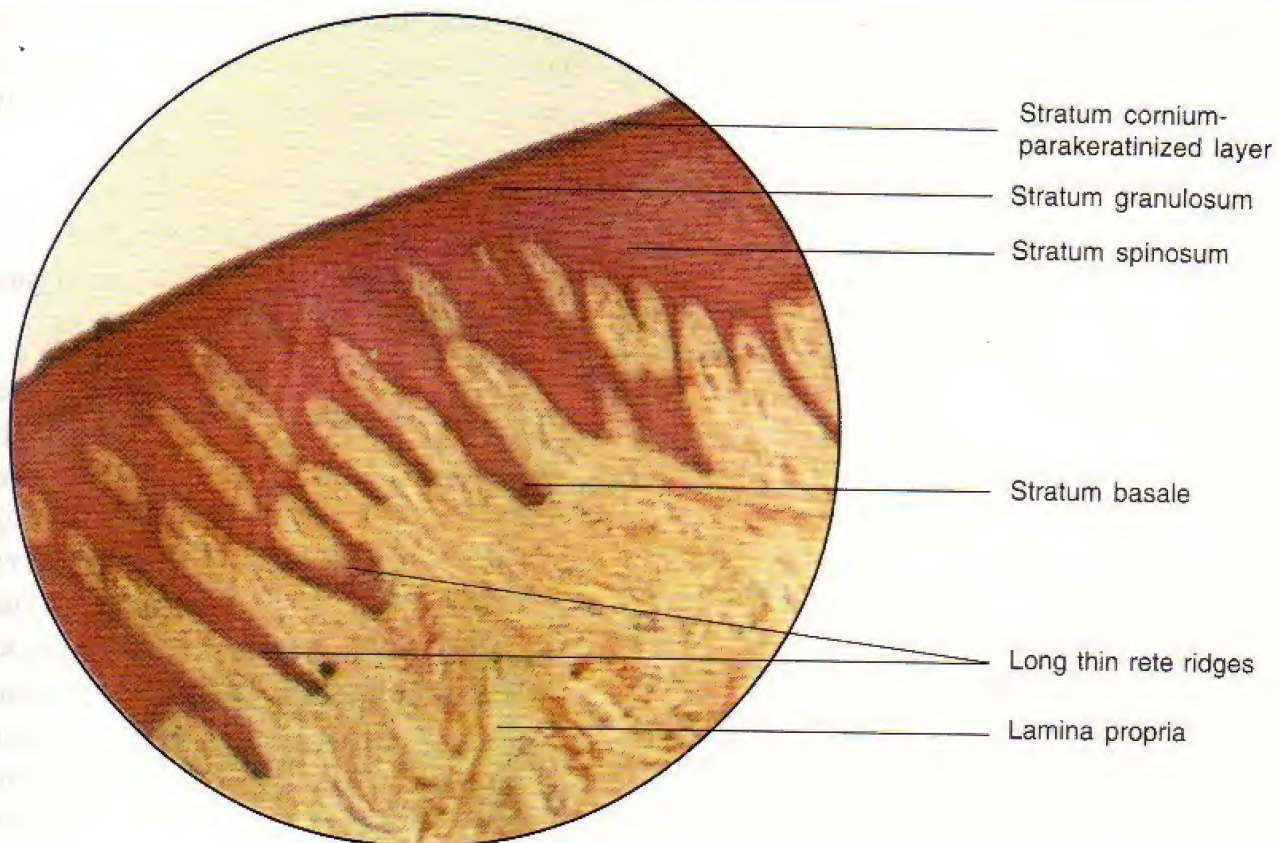
The interface between epithelium and



Identification Points Fig. No. 10.2

GINGIVA

- Lined by keratinized stratified squamous epithelium.
- Epithelium has four layers; - stratum basale, spinosum, granulosum and corneum.
- Dense lamina propria is directly attached to the periosteum of alveolar bone.



Gingiva ((Photomicrograp 4X)

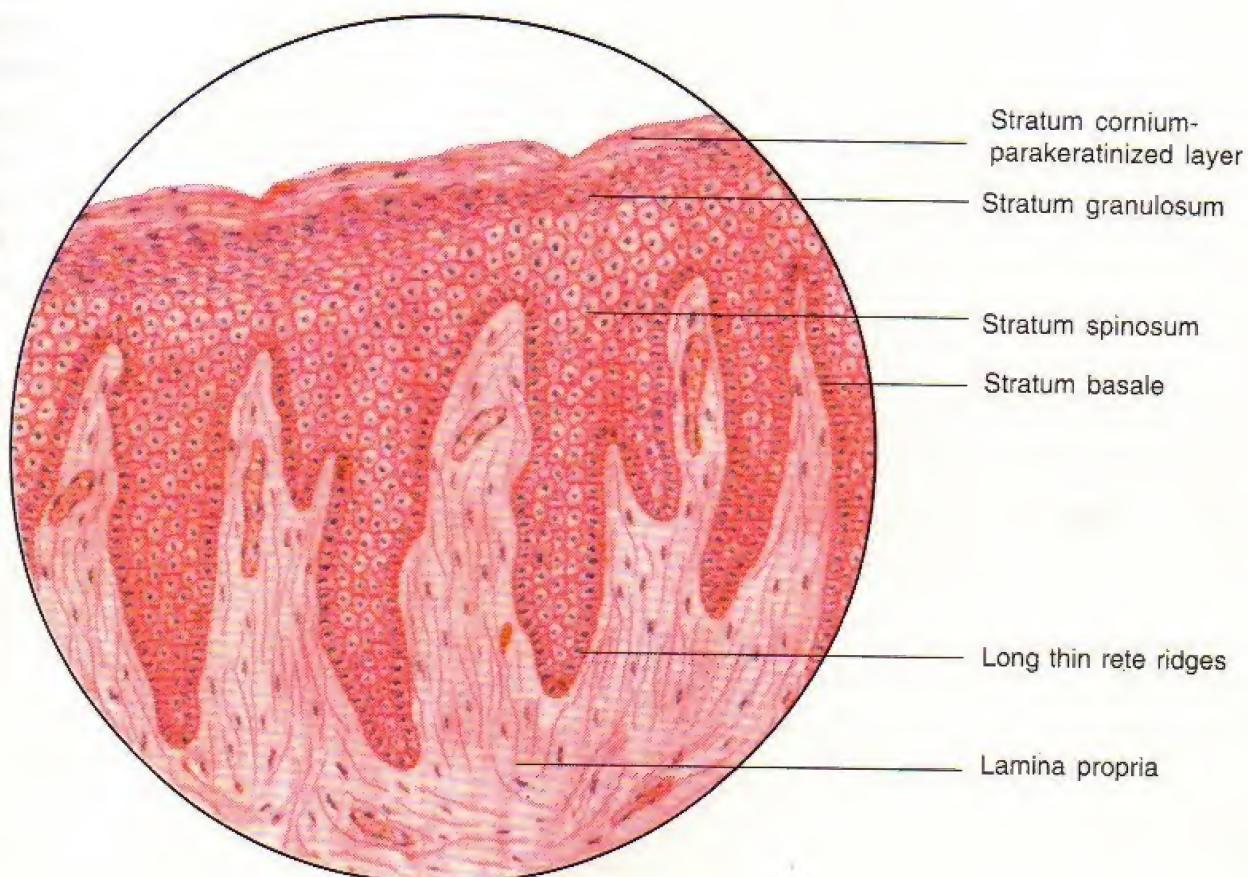


Fig.10.2 Gingiva

connective tissue is irregular with long irregular epithelial ridges. Lamina propria shows dense bundles of collagen fibers.

Sub mucosa is absent and lamina propria is directly attached to periosteum of alveolar bone. This type of attachment is called mucoperiosteal attachment which makes the attachment between epithelium and connective tissue firm and immobile.

Hard palate - anterolateral region (fatty zone) (Fig. 10.3)

Hard palate is lined by masticatory mucosa and therefore structurally somewhat similar to gingiva. The anterolateral region of the palate is lined by keratinized stratified squamous epithelium with four distinct layers i.e. stratum basale, stratum spinosum, stratum granulosum, stratum corneum. The epithelial ridges are long and regular inter digitating with connective tissue papillae. Lamina propria is dense and is more thicker than in the posterior region of hard palate. In contrast to gingiva this region has submucosa filled with fat tissue. The zone of fat tissue is



Identification Points Fig. No. 10.3

FATTY ZONE OF HARD PALATE

- Lined by keratinized stratified squamous epithelium.
- Epithelium has four layers; - stratum basale, spinosum, granulosum and corneum
- Submucosa is present containing fat tissue.

divided in to compartments by vertical band of dense connective tissue which attaches mucosa firmly to the periosteum of palatal bone.

Hard palate - posterolateral region (glandular zone) (Fig. 10.4)

Glandular zone is structurally similar to fatty zone

with overlying keratinized stratified squamous epithelium having four distinct layers i.e. stratum basale, stratum spinosum, stratum granulosum and stratum corneum. The rete ridges are long and regular interdigitating with connective tissue papilla. Lamina propria is dense and is less thicker than in the anterior region of palate. In contrast to anterolateral region submucosa contains minor



Identification Points Fig. No. 10.4

GLANDULAR ZONE OF HARD PALATE

- Lined by keratinized stratified squamous epithelium.
- Epithelium has four layers; - stratum basale, spinosum, granulosum and corneum
- Submucosa is present containing glandular tissue.

salivary gland tissue. The zone of submucosa is divided in to compartments by vertical band of dense connective tissue which attaches mucosa firmly to the periosteum of palatal bone.

Vermilion border of lip (transitional zone) (Fig. 10.5)

This zone is the transitional zone between the skin lining the outer surface of the lip and the labial mucosa lining the inner aspect. The skin is composed of keratinized stratified squamous epithelium with all appendages like hair follicles, sweat glands and sebaceous glands. The labial



Identification Points Fig. No. 10.5

VERMILION BORDER OF LIP

- Transitional zone of lip
- Lined by thin para keratinized epithelium.
- Long thin connective tissue papillae containing many capillary loops.

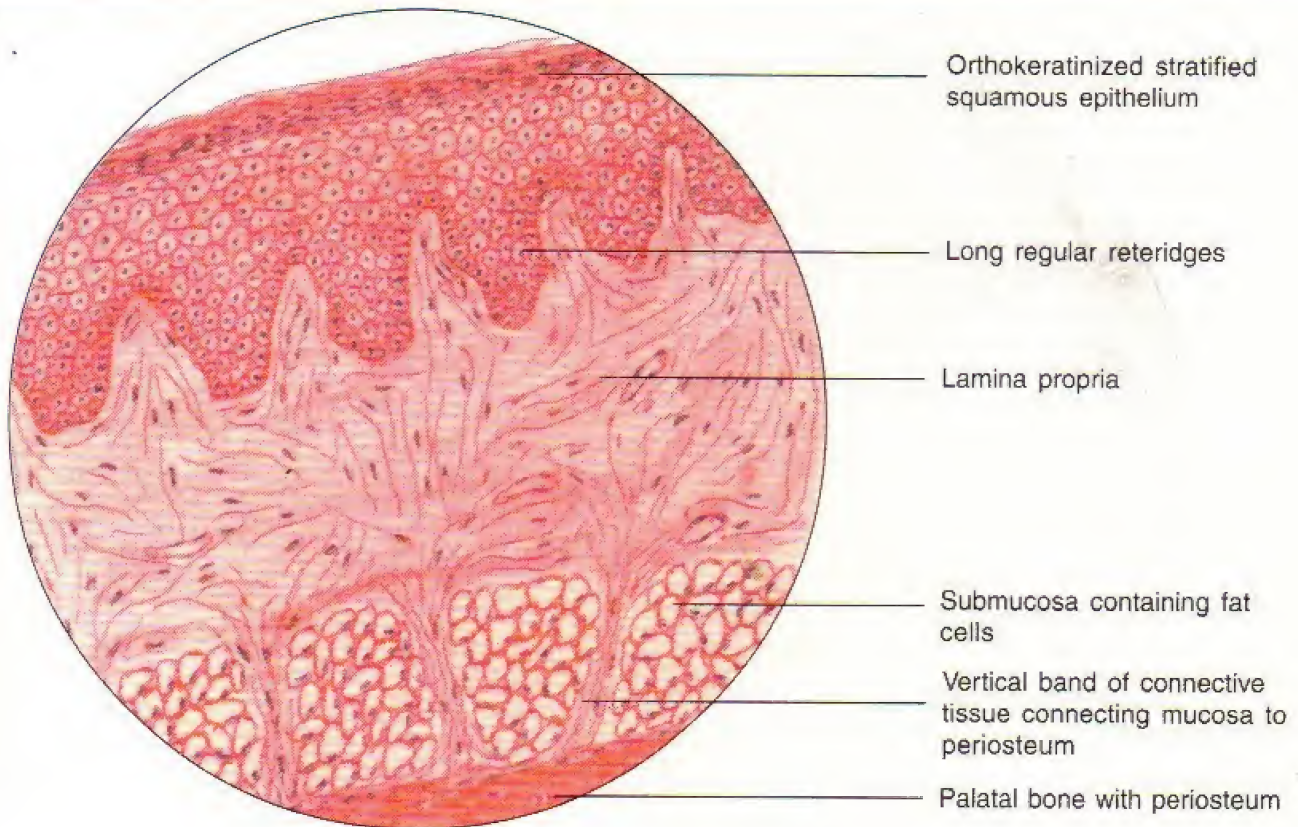


Fig. 10.3 Anterolateral area of palate (Fatty zone)

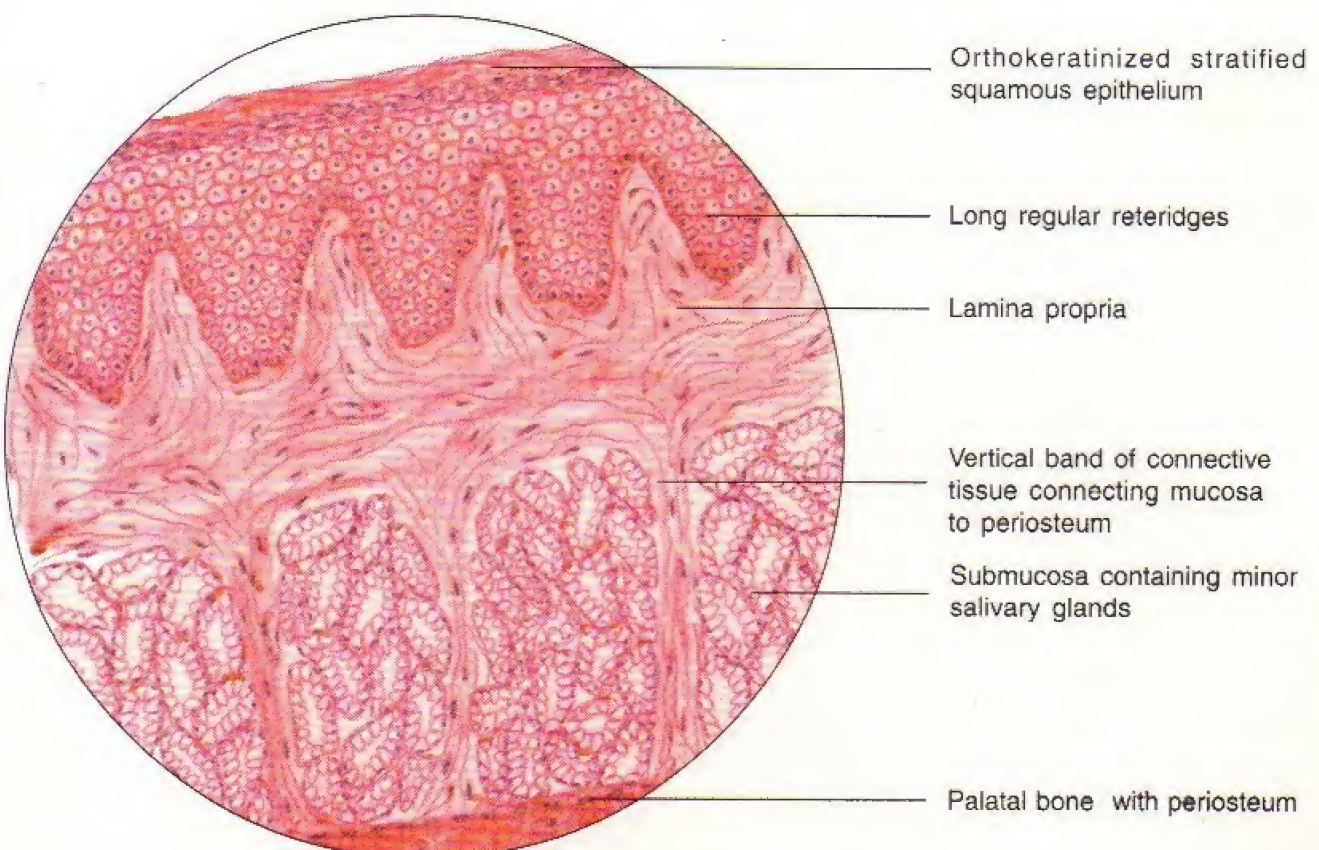
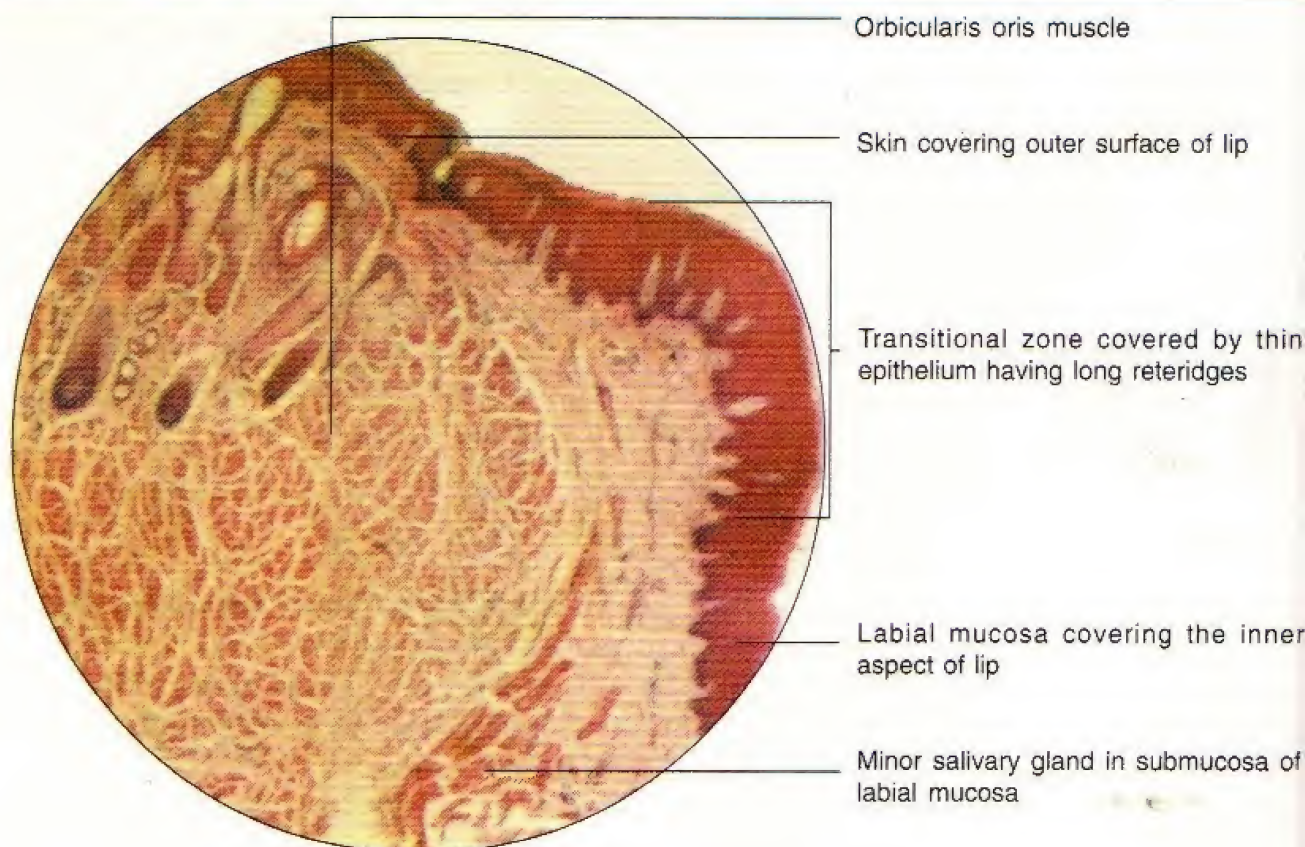


Fig. 10.4 Posterolateral region of palate (Glandular zone)



Vermilion zone of lip (Photomicrograph 4X)

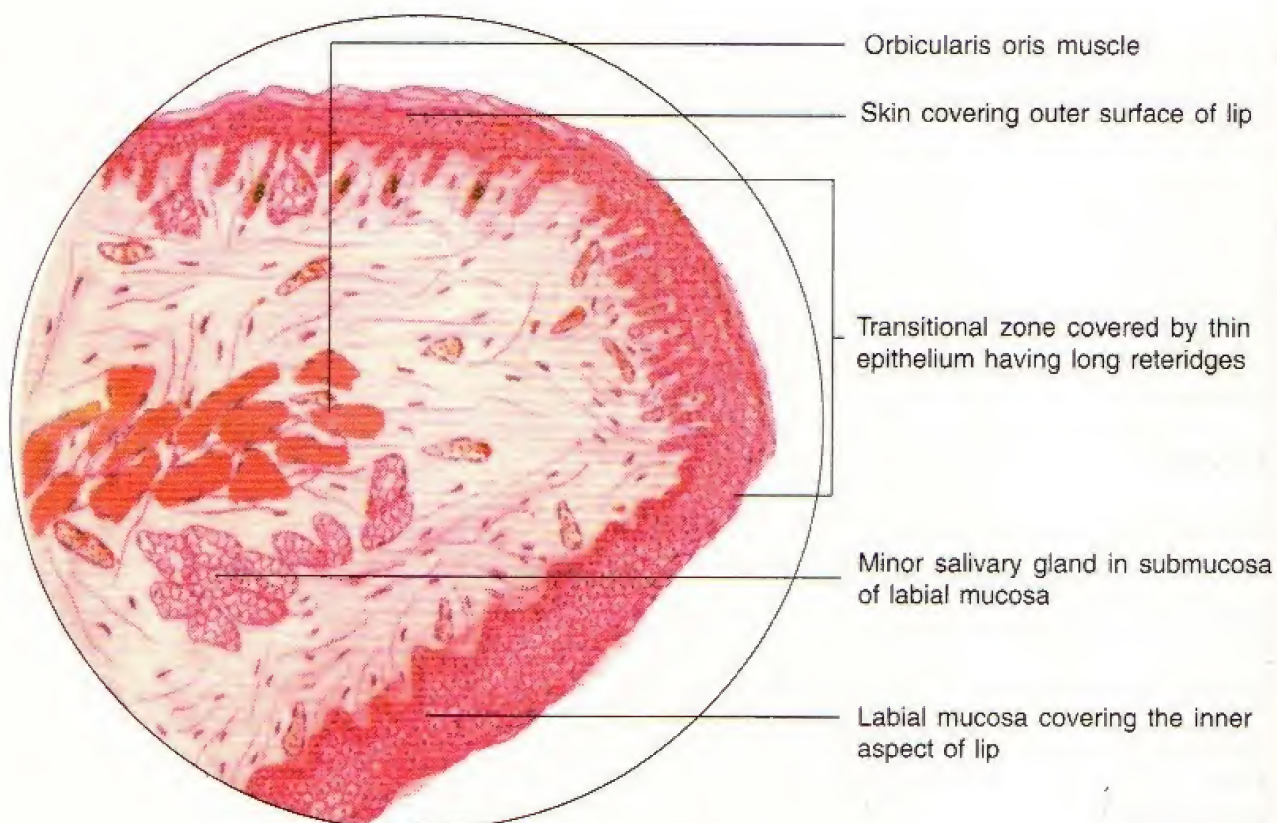


Fig. 10.5 Vermilion zone of lip

mucosa is lined by non keratinized stratified squamous epithelium. The connective tissue beneath shows minor salivary gland tissue. The central portion of lip shows orbicularis oris muscle. The transitional zone has a thin lining epithelium with thin keratinization on the surface. There are many long papillae reaching high in to epithelium carrying many capillary loops. This makes it more red compared to labial mucosa. Underlying connective tissue is characteristically devoid of glands.

Papillae of the tongue

Filiform papillae (Fig. 10.6)

Filiform (hair like) papillae are seen as hair like or thread like projection on the dorsal aspect of the tongue. Filiform papilla in a histological section is seen as cone shaped structure lined by stratified squamous epithelium with thick keratin on the surface. Central core of connective tissue supports the blood vessels. *Taste buds are not seen in these papillae.*

KEY Identification Points Fig. No. 10.6

FILIFORM PAPILLAE

- Seen as hair or finger like projections
- Lined by keratinized stratified squamous epithelium
- Do not contain taste buds

Circumvallate papillae (Fig. 10.7)

The circumvallate (walled) papillae are seen in the anterior two third of the tongue just anterior to sulcus terminalis. These are 10-12 in number. The superficial surface of these papillae is at the level of surface of tongue and a 'V' shaped sulcus is present all around the papillae separating them from the adjacent portion of tongue. The lining epithelium is keratinized stratified squamous



Key Box 10.7

CIRCUMVALLATE PAPILLAE

- Lined by keratinized epithelium on superficial surface and non keratinized epithelium on the lateral surface.
- Taste buds are seen on the lateral surface
- Von Ebner's glands are present in the connective tissue.

epithelium at the superficial surface and non keratinized on the lateral surface of circumvallate papillae. Taste buds are seen only on the lateral surface. Central portion is occupied by the connective tissue. The characteristic feature of this papilla is presence of serous minor salivary glands (von Ebner's gland) in the connective tissue beneath it. These glands secrete watery saliva in to the 'V' shaped trough around the papillae to flush out the food debris.

Fungiform papillae (Fig. 10.8)

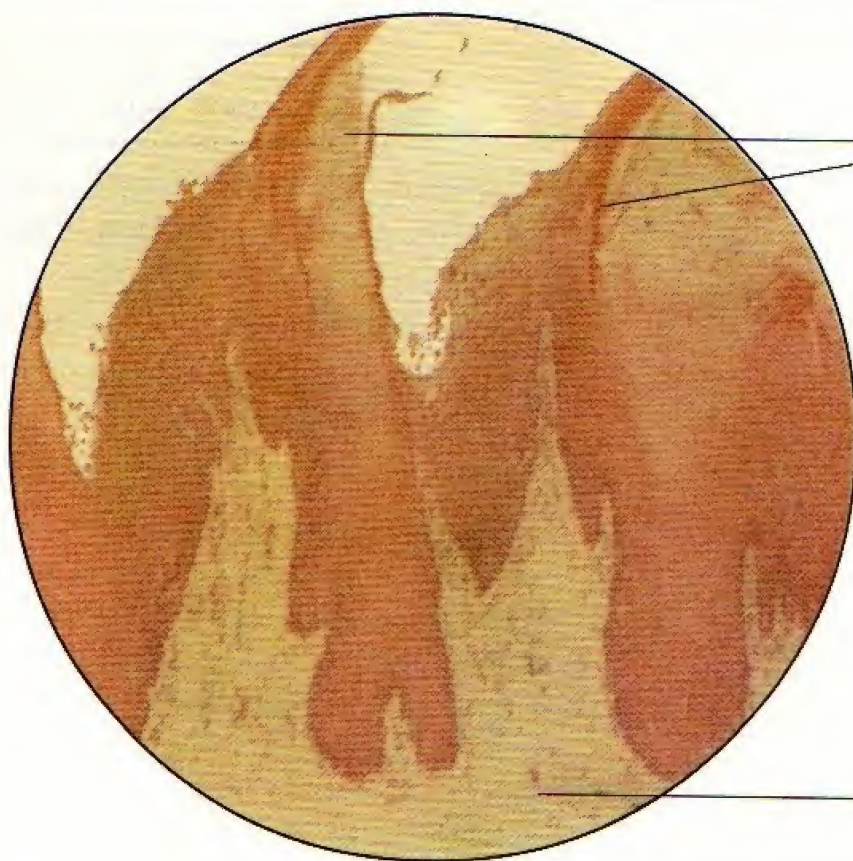
Fungiform (fungus like) papillae are dome shaped structures projecting above the surface of the tongue and located between the filiform papillae. The epithelium covering the fungiform papillae is thin nonkeratinized stratified squamous epithelium making this papilla reddish in colour. The superficial surface of the papillae contain few taste buds. The supporting connective tissue shows collagen fibers, fibroblasts and blood vessels.



Identification Points Fig. No. 10.8

FUNGIFORM PAPILLAE

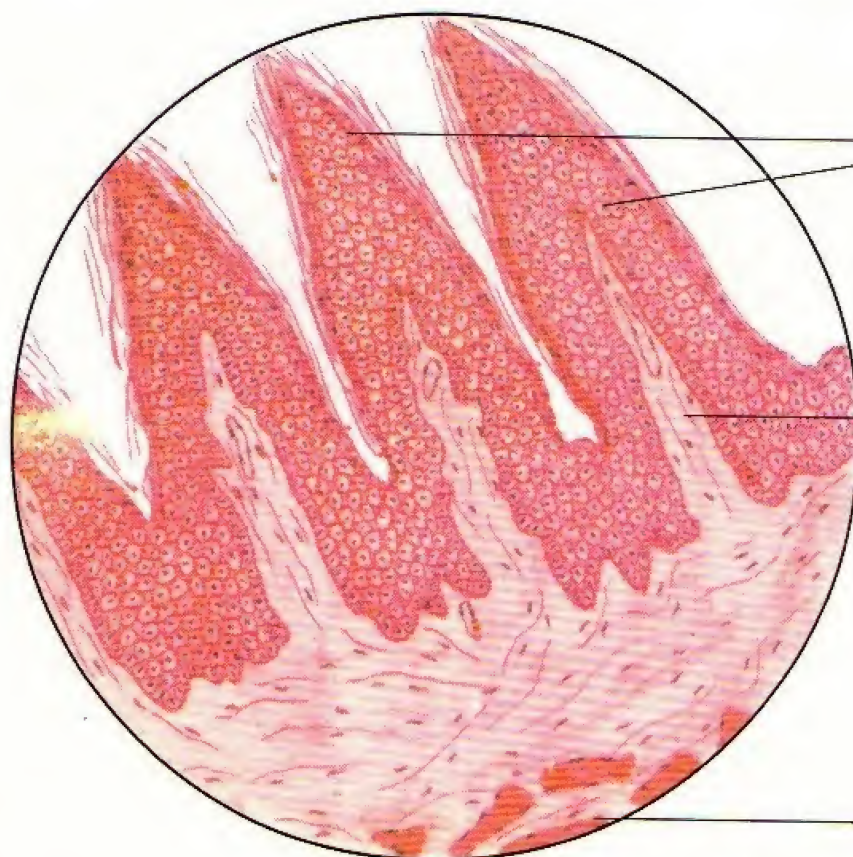
- Dome shaped projections
- Lined by non keratinized epithelium
- Taste buds are seen on superficial surface.



Filiform papillae lined by
keratinized epithelium

Connective tissue core of
papilla

Filiform papillae of tongue (Photomicrograph 4X)

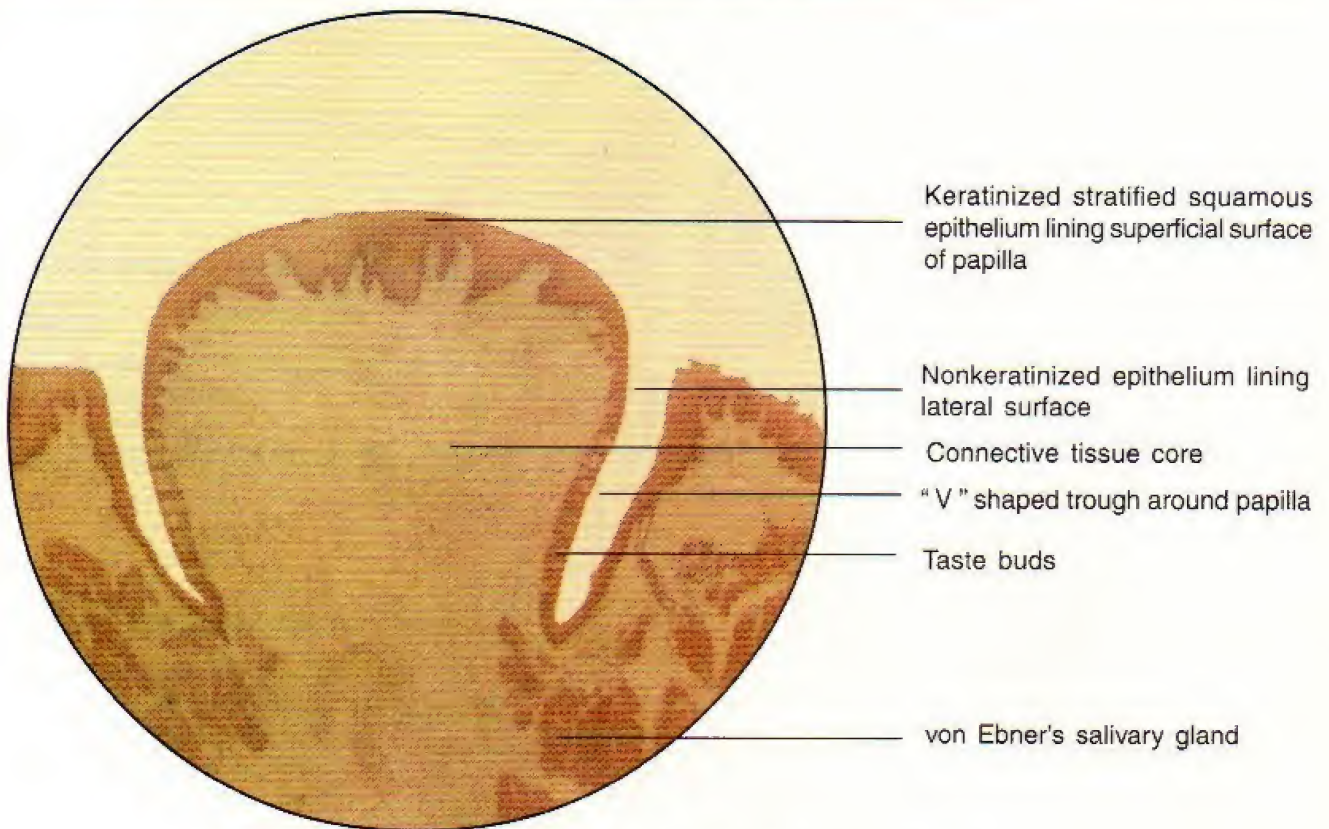


Filiform papillae lined by
keratinized epithelium

Connective tissue core of
papilla

Submucosa containing
muscle

Fig. 10.6 Filiform papillae of tongue



Circumvallate papilla of tongue (Photomicrograph 4X)

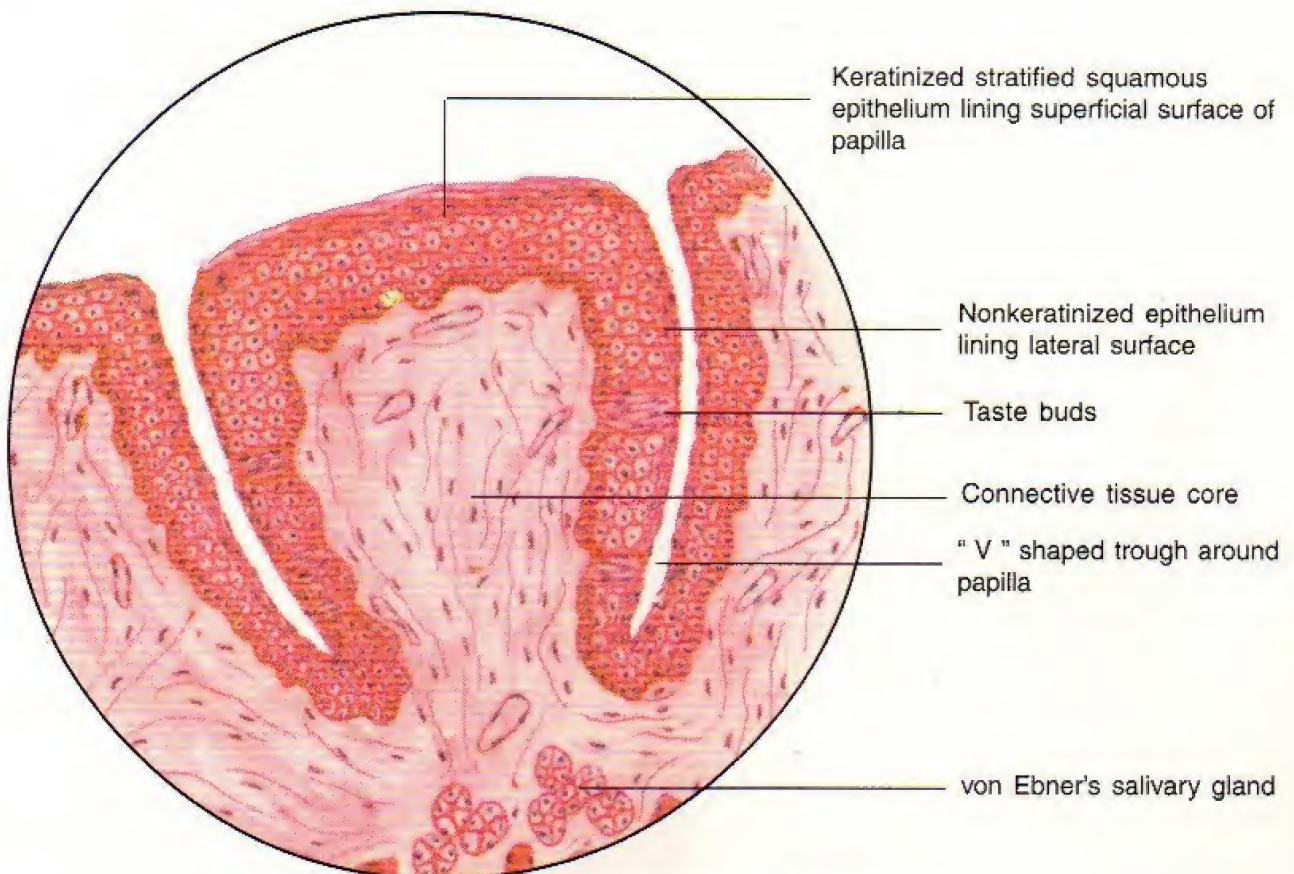


Fig. 10.7 Circumvallate papilla of tongue

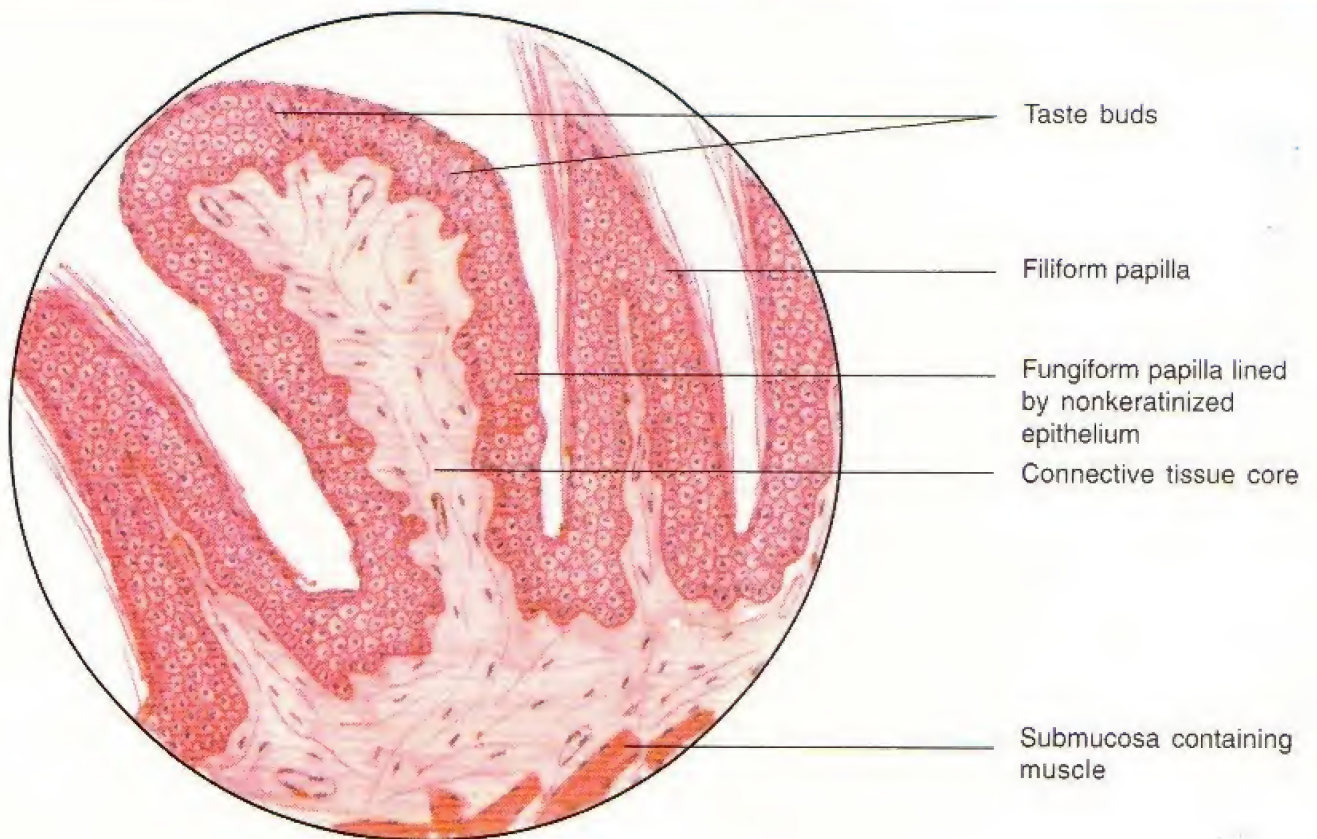


Fig. 10.8 Fungiform papillae of tongue

11

Salivary Gland

- Structure of salivary glands
 - Serous gland
 - Mucous gland
 - Mixed gland

Salivary glands are exocrine glands which secrete saliva that reaches the oral cavity through their ducts. There are three pairs of major salivary glands located extra orally and numerous minor salivary glands situated intraorally. Based on the type of secretion salivary glands are divided in to

- Serous gland- Parotid & von Ebners gland
- Mucous glands- Sublingual gland and all the minor salivary glands except for von Ebners glands.
- Mixed gland –submandibular salivary gland.

Both major and minor salivary glands are composed of parenchymal components supported by the connective tissue. Parenchymal component includes secretory acini and ductal system. Connective tissue forms a capsule around the gland and extends in between the acini to divide the gland in to lobes and lobules. Connective tissue carries the blood vessels and nerves.

SEROUS SALIVARY GLAND – Parotid gland (Fig. 11.1)

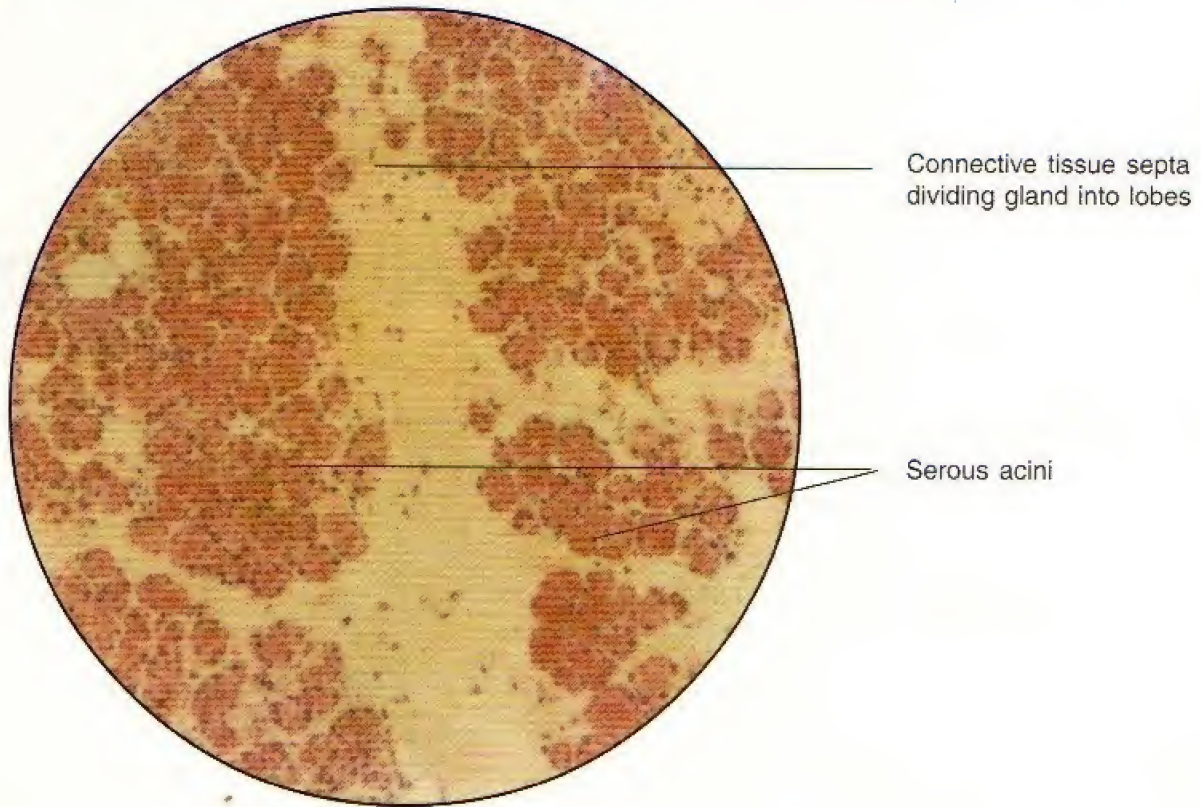
Serous salivary gland is composed of numerous serous secretory units called serous acini. Serous acinus is a collection of many serous cells. Serous cells are the secretory cells and are pyramidal in shape with a broad base resting on a basement membrane and a narrow apex facing towards the lumen. Nucleus is round and located at the basal 1/3 of the cell. Apical part of the cytoplasm is filled with zymogen granules and appears eosinophilic in a hematoxylin and eosin stained section. Serous cells are arranged to form an acinus. Serous acinus is round or circular in shape, has fewer cells and a small lumen. Salivary gland is divided into lobes by connective tissue septa that carry blood vessels. Intra lobular and inter lobular ducts are seen.



Identification Points Fig. No. 11.1

SEROUS SALIVARY GLAND

- Composed of round acini with small lumen
- Nucleus of cells is ovoid and present at basal one third
- Apical cytoplasm stain eosinophilic because of secretory granules



Serous salivary gland (Photomicrograph 10X)

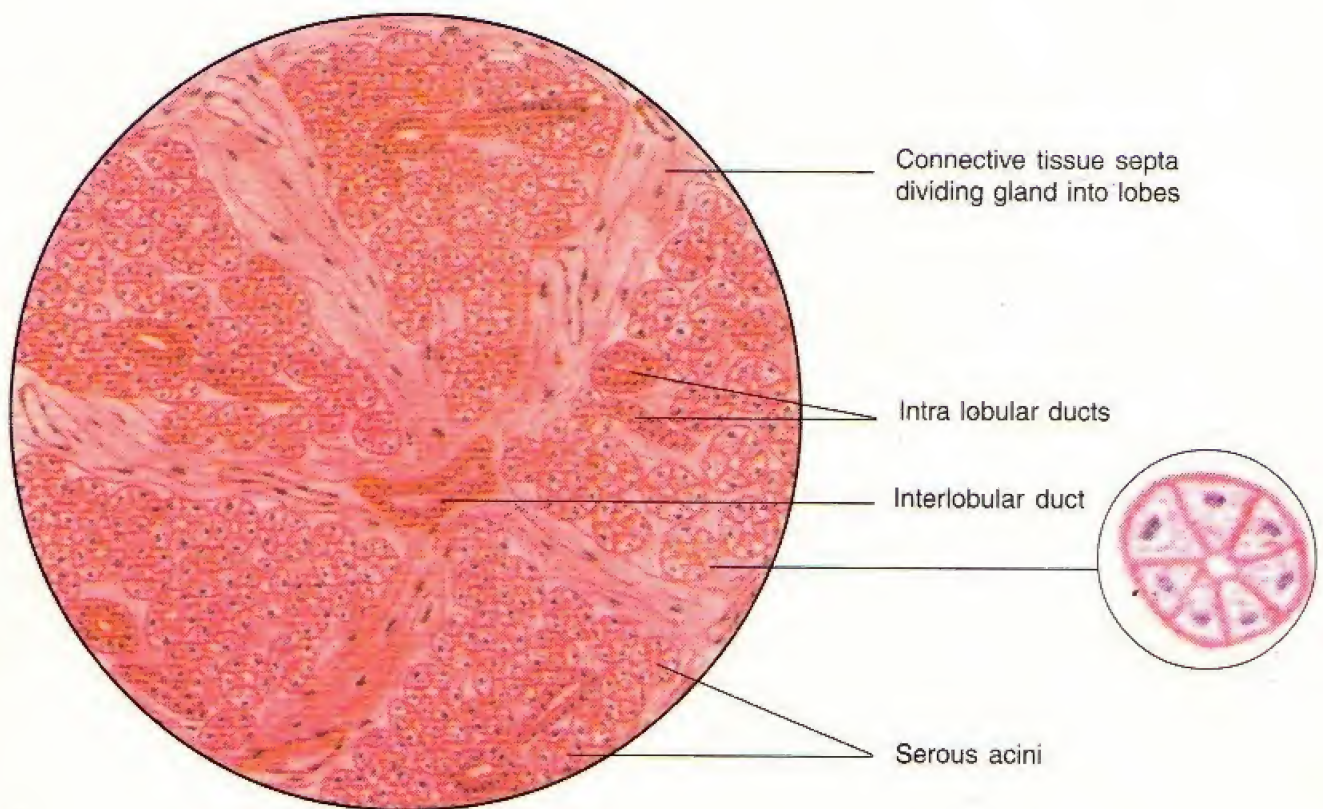


Fig. 11.1 Serous salivary gland

MUCOUS SALIVARY GLAND – Sublingual gland (Fig. 11.2)

Mucous salivary glands have numerous secretory units called mucous acini. These acini are collection of mucous cells. Mucous cells are columnar in shape with nucleus flattened and pressed against the basement membrane. Cytoplasm is restricted to basal region. Apical portion of the cell is filled with mucous secretory droplets and appear empty in H & E stained sections. Mucin can be stained positively using periodic acid Schiff stain. Mucous cells are arranged to form mucous acini that are ovoid or tubular with large lumen. In a histologic section along with acini intra lobular ducts are also seen. Connective tissue septa is present between the

acini that shows blood vessels and inter lobular ducts.

MIXED SALIVARY GLAND – Submandibular gland (Fig. 11.3)

In a mixed salivary gland both serous and mucous acini are seen. The number can vary depending on predominantly serous or mucous. Along with these acini mixed acini are also seen having both serous and mucous cells. In a mixed acinus the basic secretory unit is a typical mucous acinus in a tubular shape. The blind end of this tubular structure is capped by a group of serous cells that form a crescent shaped structure. This crescent shaped structure is called 'demilune of Gianuzzi'. Intra lobular and inter lobular ducts, connective tissue septa are also seen.



Identification Points Fig. No. 11.2

MUCOUS SALIVARY GLAND

- Composed of tubular acini with large lumen
- Nucleus of cells is flat & pressed to basal plasma membrane
- Apical cytoplasm appears empty.



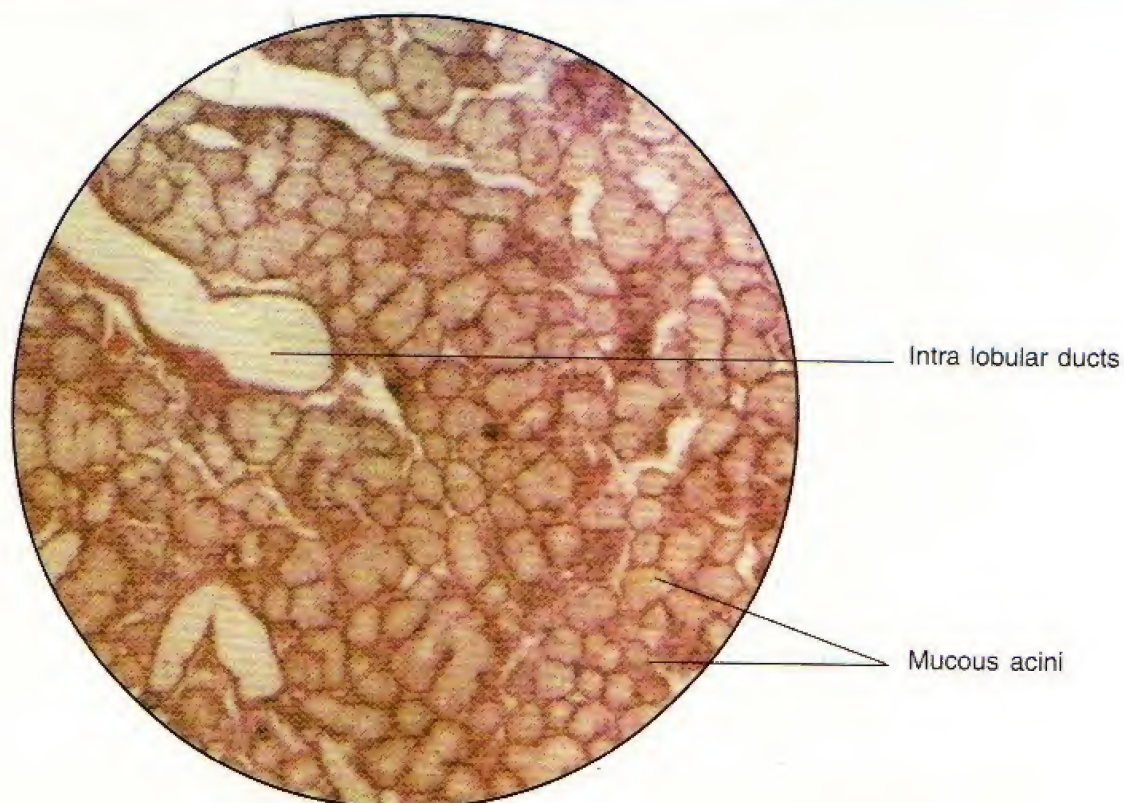
Identification Points Fig. No. 11.3

MIXED SALIVARY GLAND

- Contains both serous and mucous acini.
- The blind end of mucous acini has serous demilunes
- Demilunes are crescent shaped and named as 'demilune of Gianuzzi'

Table 11.1 Differences between serous and mucous acini

SEROUS ACINI	MUCOUS ACINI
<ul style="list-style-type: none"> • Circular or round in shape • Smaller in size • Composed of less number of cells • Has small lumen • Cells are pyramidal in shape • Nucleus is round and placed at basal 1/3 of the cell • Apical cytoplasm appears eosinophilic because of zymogen granules 	<ul style="list-style-type: none"> • Ovoid or tubular in shape • Larger • More number of cells • Wider lumen • Cells are columnar in shape • Nucleus is flattened and pressed against basal plasma membrane of the cell • Apical cytoplasm appears empty in H & E stained sections



Mucous salivary gland (Photomicrograph 10X)

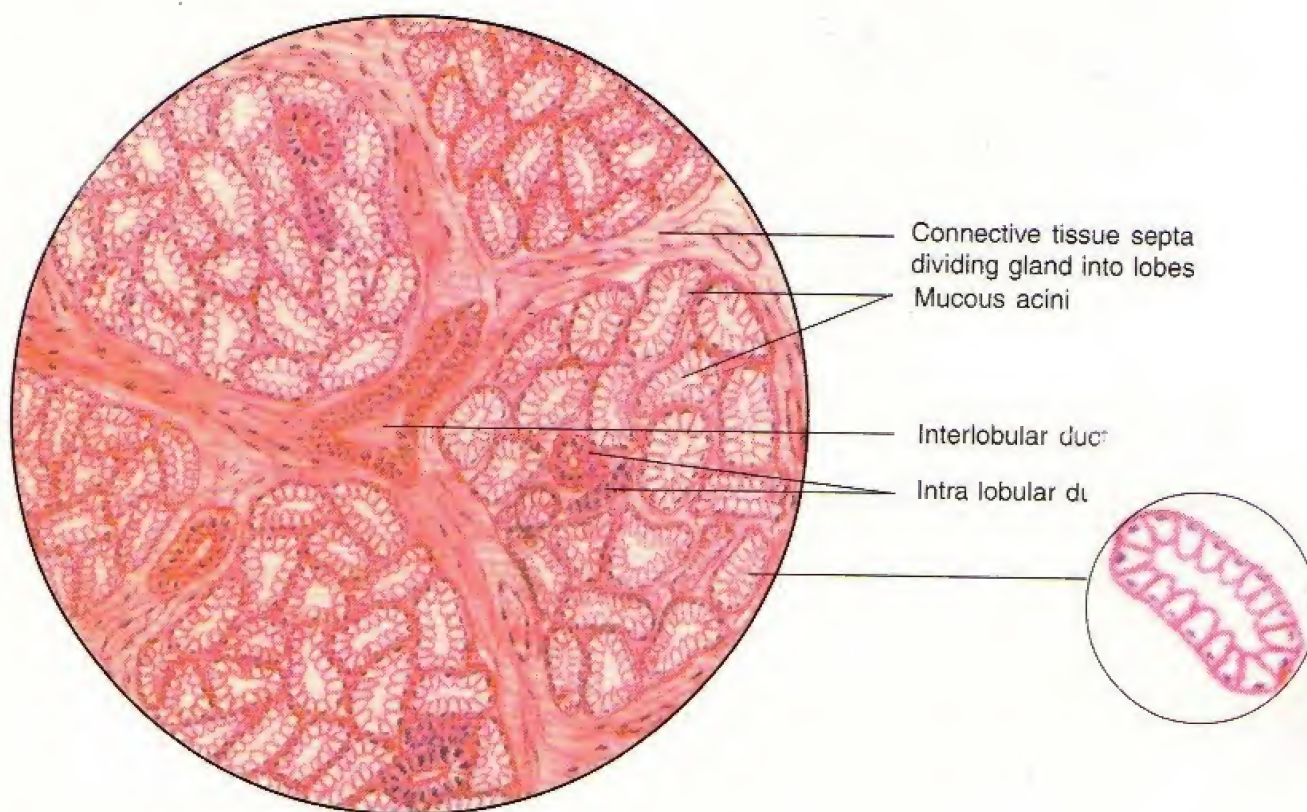
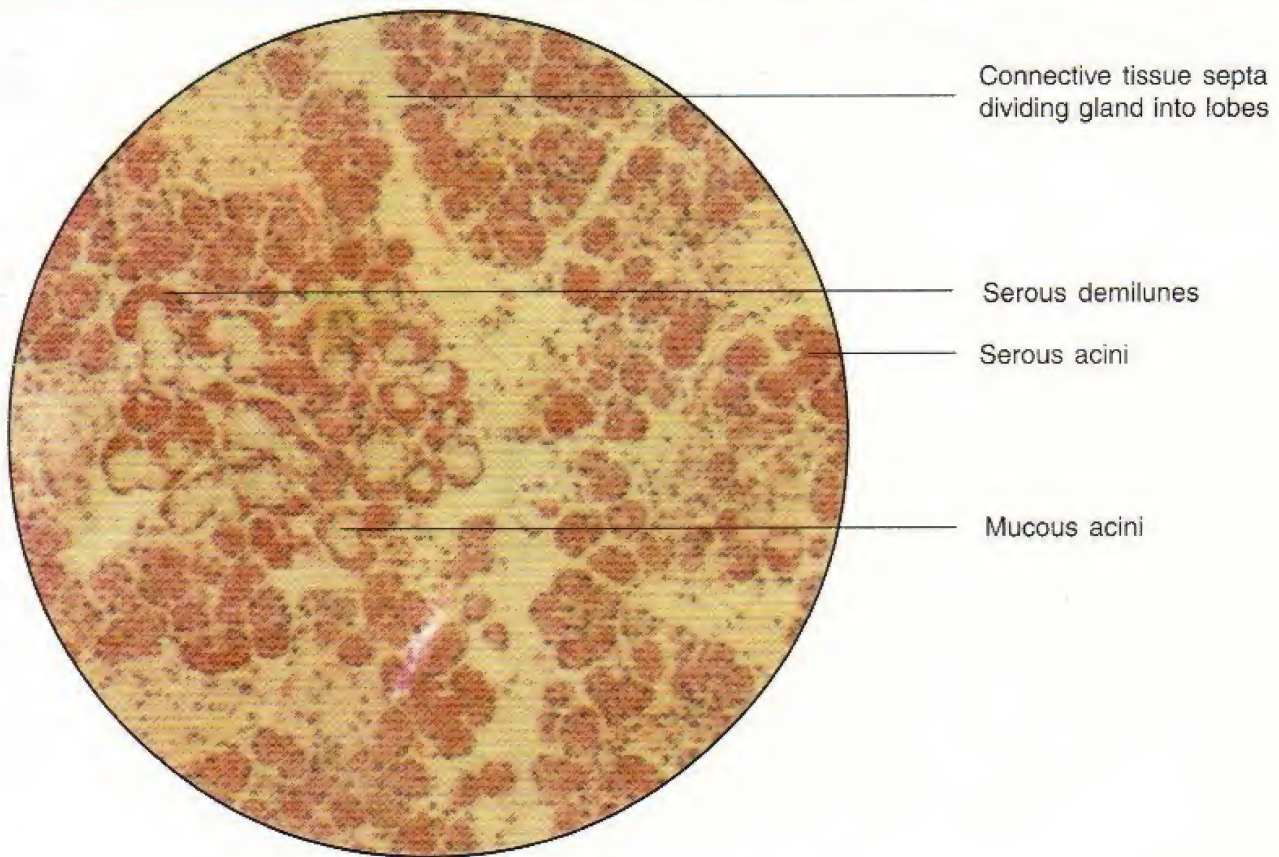


Fig. 11.2 Mucous salivary gland



Mixed salivary gland (Photomicrograph 10X)

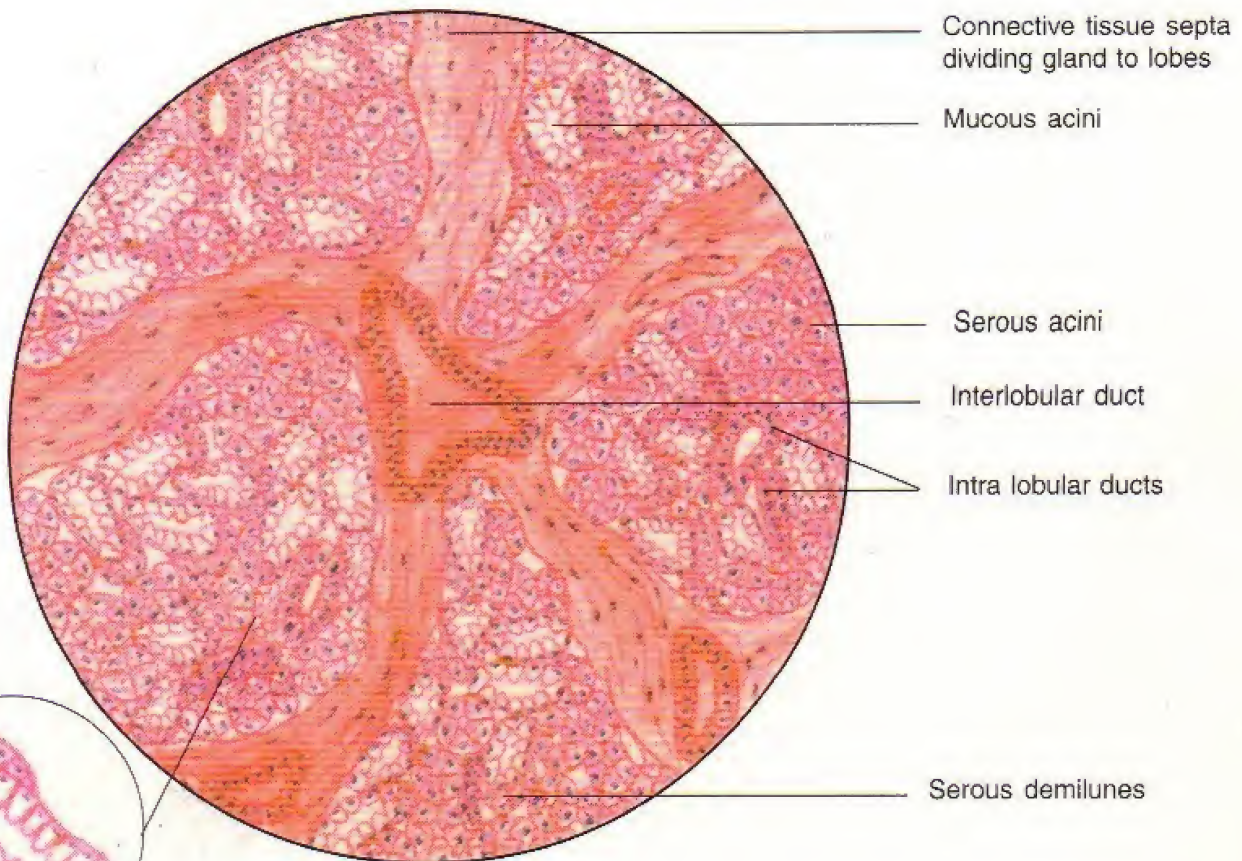


Fig. 11.3 Mixed salivary gland

Section 2

Oral Pathology

- CYSTS OF ORAL REGION
- ODONTOGENIC TUMORS
- DENTAL CARIES
- PULP AND PERIAPICAL LESIONS
- BACTERIAL AND FUNGAL INFECTIONS
- SALIVARY GLAND NEOPLASMS
- SKIN LESIONS
- BONE LESIONS
- BENIGN AND MALIGNANT TUMORS OF ORAL CAVITY
- DEVELOPMENTAL DISTURBANCES

Cysts of Oral Region

- Odontogenic keratocyst
- Dentigerous cyst
- Calcifying odontogenic cyst
- Radicular cyst
- Mucocele

Cyst is defined by Kramer as a pathological cavity having fluid, semifluid or gaseous content and which is not formed by accumulation of pus. It is usually but not always lined by epithelium. True cysts have epithelial lining while cysts devoid of epithelial lining are called pseudo cysts. When the epithelium lining the cyst is derived from odontogenic epithelium or its remnants (cell rests of Serres', cell rests of Malassez) the cyst is called as odontogenic cyst.

Cysts have 3 components -

1. Cystic cavity or lumen containing fluid or semi fluid materials,
2. Lining epithelium forming a lining of the cystic cavity
3. Connective tissue capsule that forms the wall of the cyst

ODONTOGENIC KERATOCYST (OKC)

It is a developmental odontogenic cyst that has characteristic histological features and a high rate of recurrence. Initially these lesions are asymptomatic and do not produce symptoms until it grows to larger size. Symptoms include swelling of jaw, displacement of teeth, pain if secondarily infected and pathologic fracture in later stages.

Histopathology (Fig. 12.1)

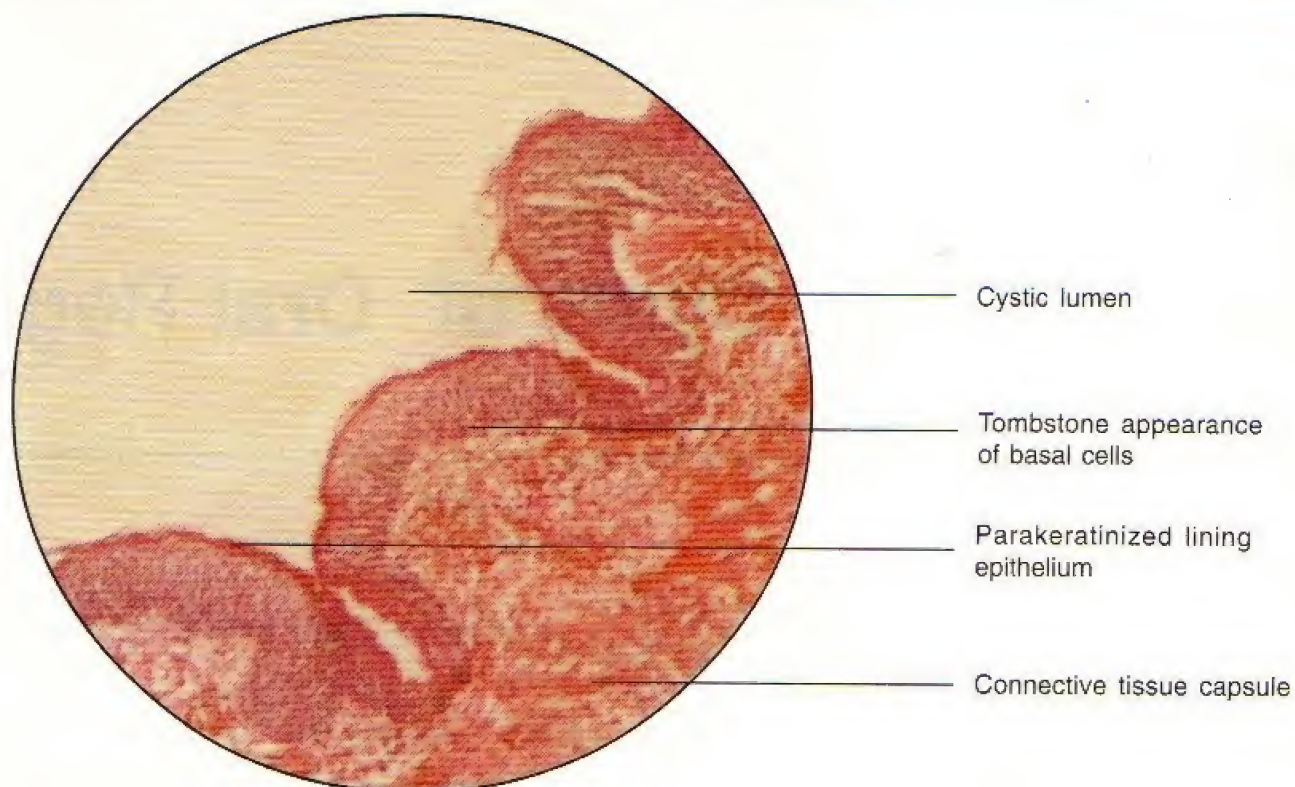
Lining epithelium of OKC is characterized by regular parakeratinized stratified squamous epithelium of 5-8 cell layer thickness, without rete ridges formation. Basal cell layer of epithelium is quite distinct with columnar cells having palisading arrangement of nuclei with



Identification Points Fig. No. 12.1

ODONTOGENIC KERATOCYST

- Keratinized lining epithelium of 5-8 cell layers thick
- 'Tombstone' appearance of basal cells
- Corrugated parakeratin layer
- Satellite cysts in cystic capsule



Odontogenic keratocyst (Photomicrograph 10X)

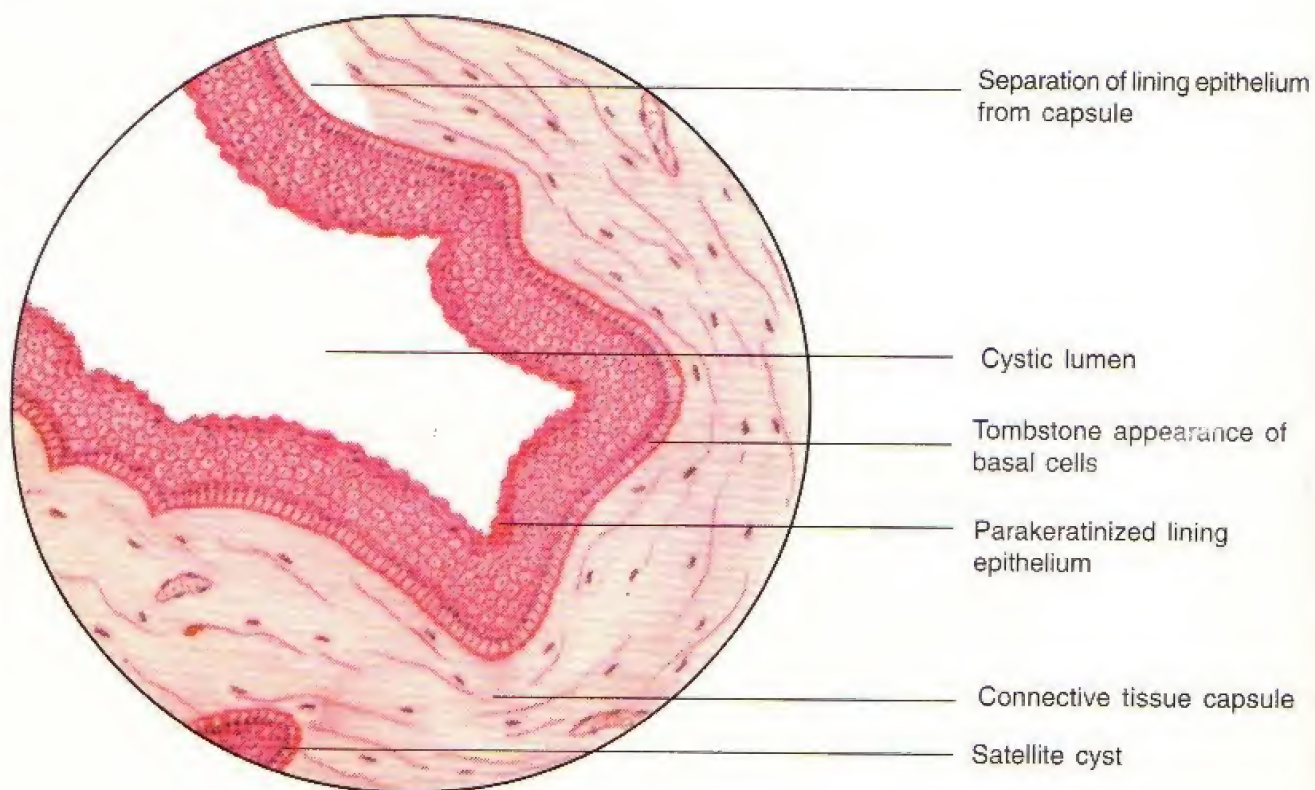


Fig. 12.1 Odontogenic keratocyst

polarization (nucleus away from basement membrane). This is described as 'tombstone' or 'picket fence' appearance. The superficial parakeratin layer shows characteristic corrugations. Epithelium may show infoldings in to the connective tissue capsule and may be separated from capsule in some areas. Connective tissue capsule comprises of parallel arranged collagen fibers with few cells and blood vessels. Satellite cysts or proliferating odontogenic cell rests may be present in the capsule. Cystic lumen contains fluid with low protein level.

DENTIGEROUS CYST (FOLLICULAR CYST)

It is a developmental odontogenic cyst that is formed by expansion of dental follicle and therefore always attached to the neck of an impacted or unerupted tooth. Initially this lesion is asymptomatic, other than a clinically missing tooth. Later stages it causes bony expansion, displacement of teeth and pain if infected.

Histopathology (Fig. 12.2)

The lining epithelium is derived from reduced enamel epithelium and hence appears as uniformly thin non keratinized epithelium. The epithelium comprises of 2-3 layers of flattened cells and is characteristically devoid of rete ridges. Connective tissue capsule is derived from dental follicle, consists of young fibroblasts widely

separated by ground substance rich in mucopolysaccharide. Connective tissue capsule may show odontogenic epithelial remnants. Cystic lumen contains cystic fluid which is thin, watery, or may be blood tinged.

CALCIFYING EPITHELIAL ODONTOGENIC CYST (GORLIN'S CYST) - SIMPLE CYSTIC TYPE (TYPE 1 - A)

This is a type of developmental odontogenic cyst that has many features of odontogenic tumor. COC can occur as a central (intraosseous) or peripheral (extraosseous) lesion. Extraosseous lesions manifest as gingival swelling. Central lesions are initially asymptomatic, later presents as painless swelling of the jaw.

Histopathology (12.3)

Microscopically simple cystic type of COC shows lining epithelium of variable thickness, or may be of regular thickness with 5-10 cell layers thick. Basal cells are columnar with palisading arrangement of hyperchromatic nuclei that are arranged away from basement membrane (resembling ameloblast). Spinous cells are loosely arranged and widely separated and may appear star shaped resembling stellate reticulum. One of the remarkable features of COC is presence of **ghost cells**. Ghost cells are degenerating epithelial cells that appear as ovoid, eosinophilic cells with nucleus showing different stages of

KEY Identification Points Fig. No. 12.2

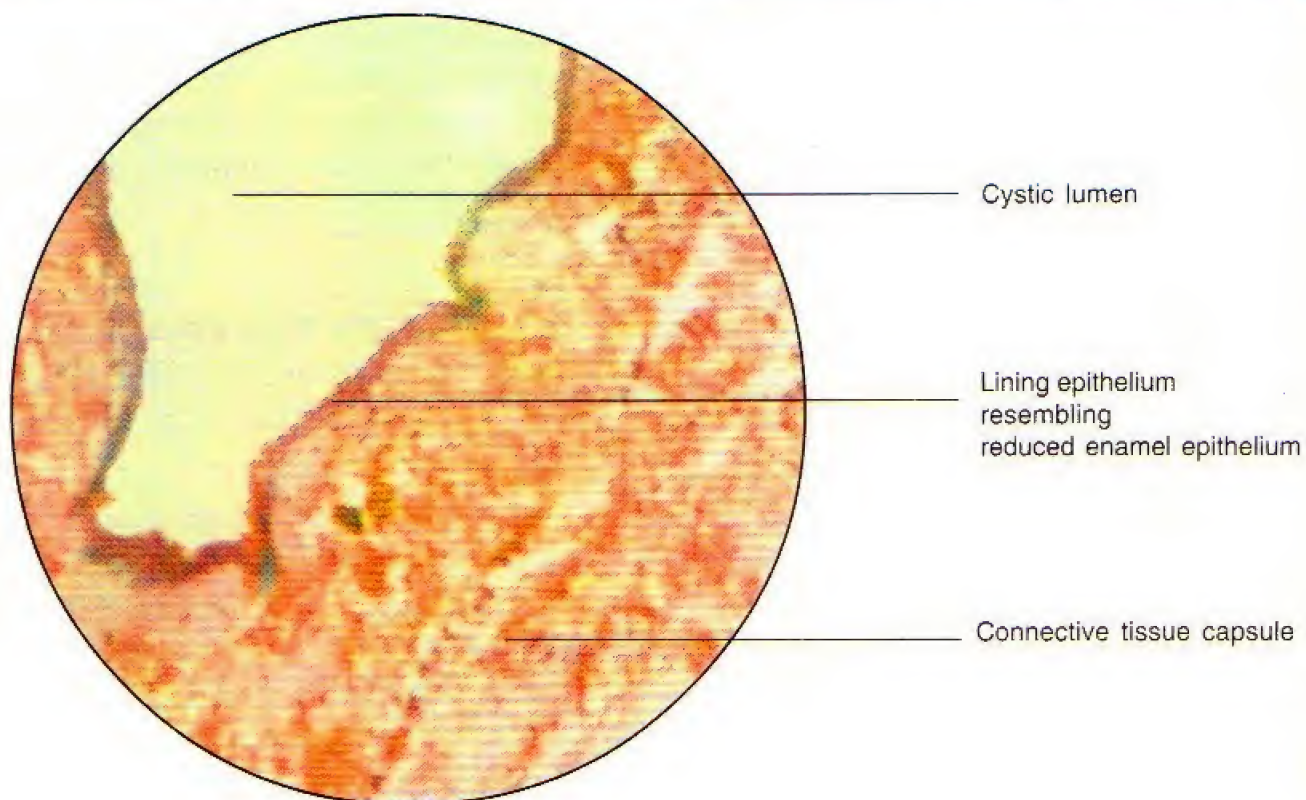
DENTIGEROUS CYST

- Non keratinized epithelium of 2-3 cell layers thick
- Lining epithelium similar to reduced enamel epithelium
- Cyst attached to neck of tooth
- Odontogenic epithelial islands in capsule

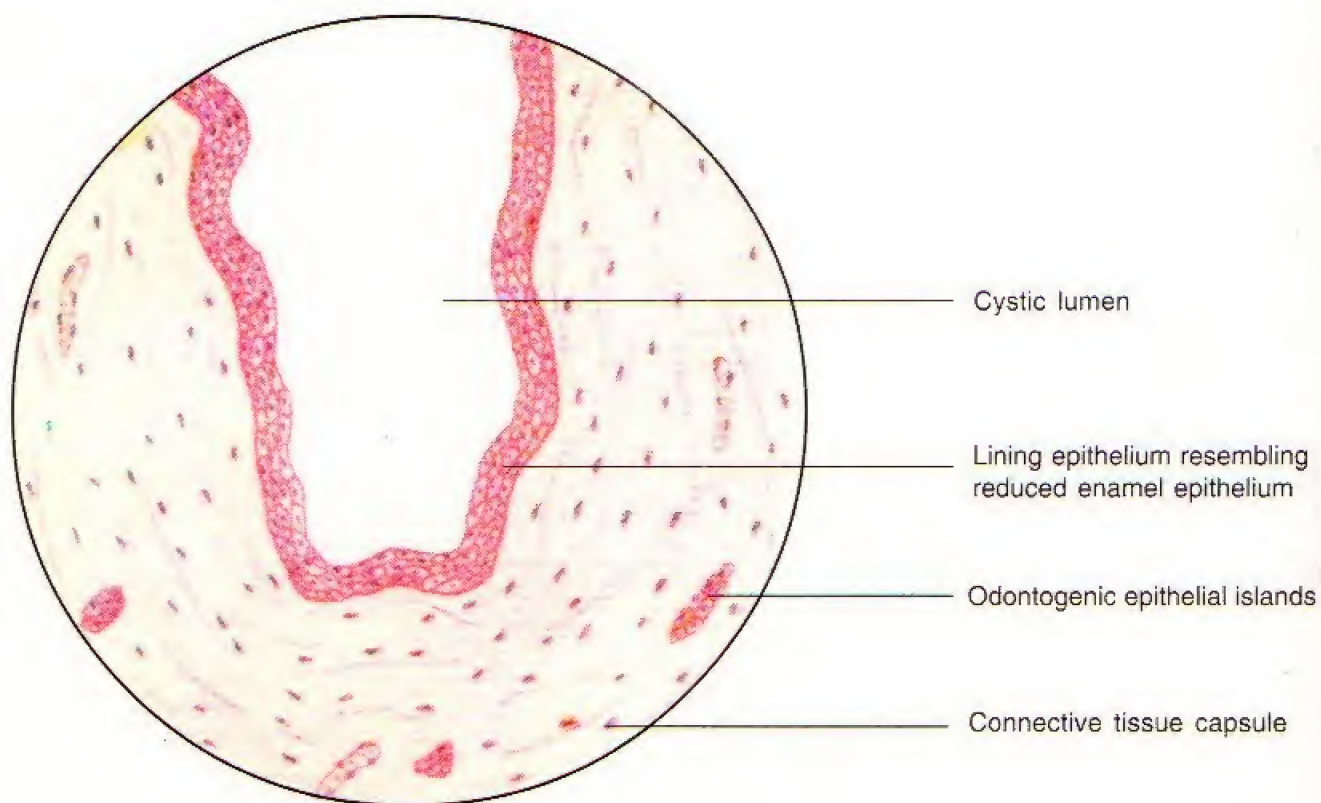
KEY Identification Points Fig.No.12.3

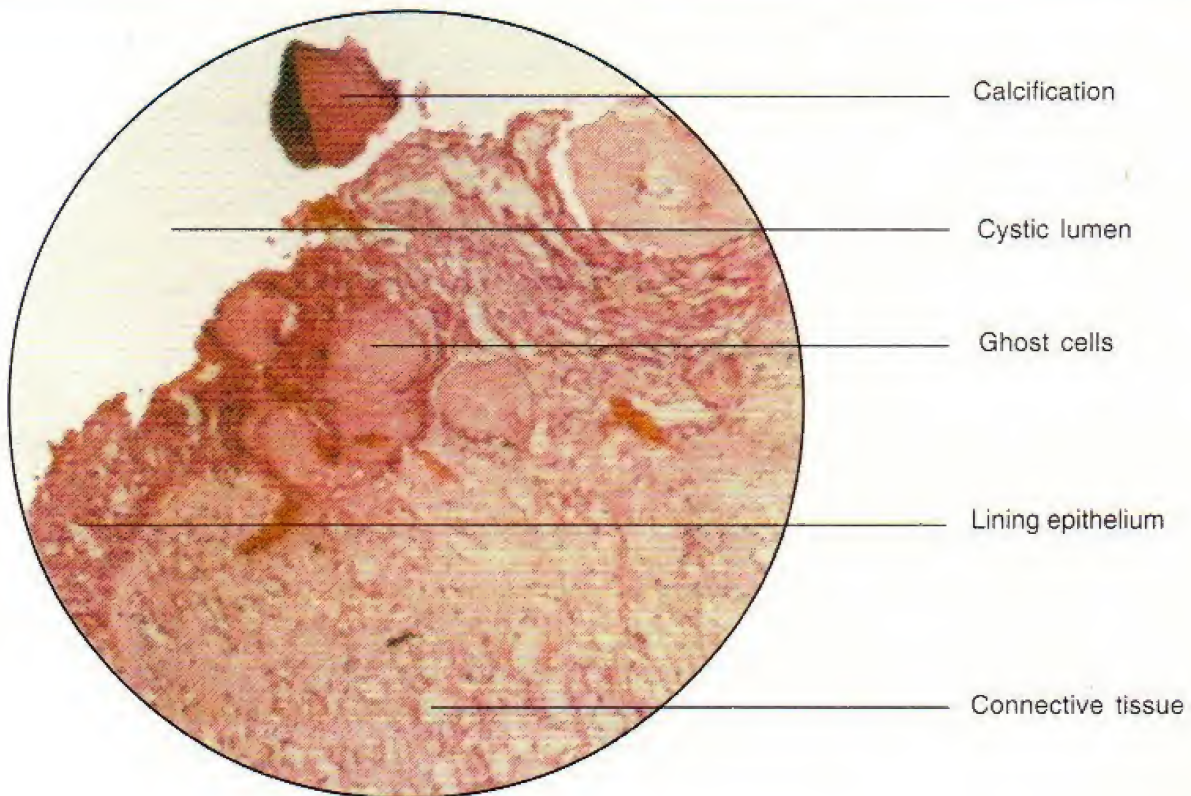
CALCIFYING EPITHELIAL ODONTOGENIC CYST

- Lining epithelium of 5-8 cell layers thick
- Basal cells similar to ameloblasts
- Presence of ghost cells
- Dentinoid induction just beneath the lining epithelium.



Dentigerous cyst (Photomicrograph 10X)





Calcifying odontogenic cyst (Photomicrograph 10X)

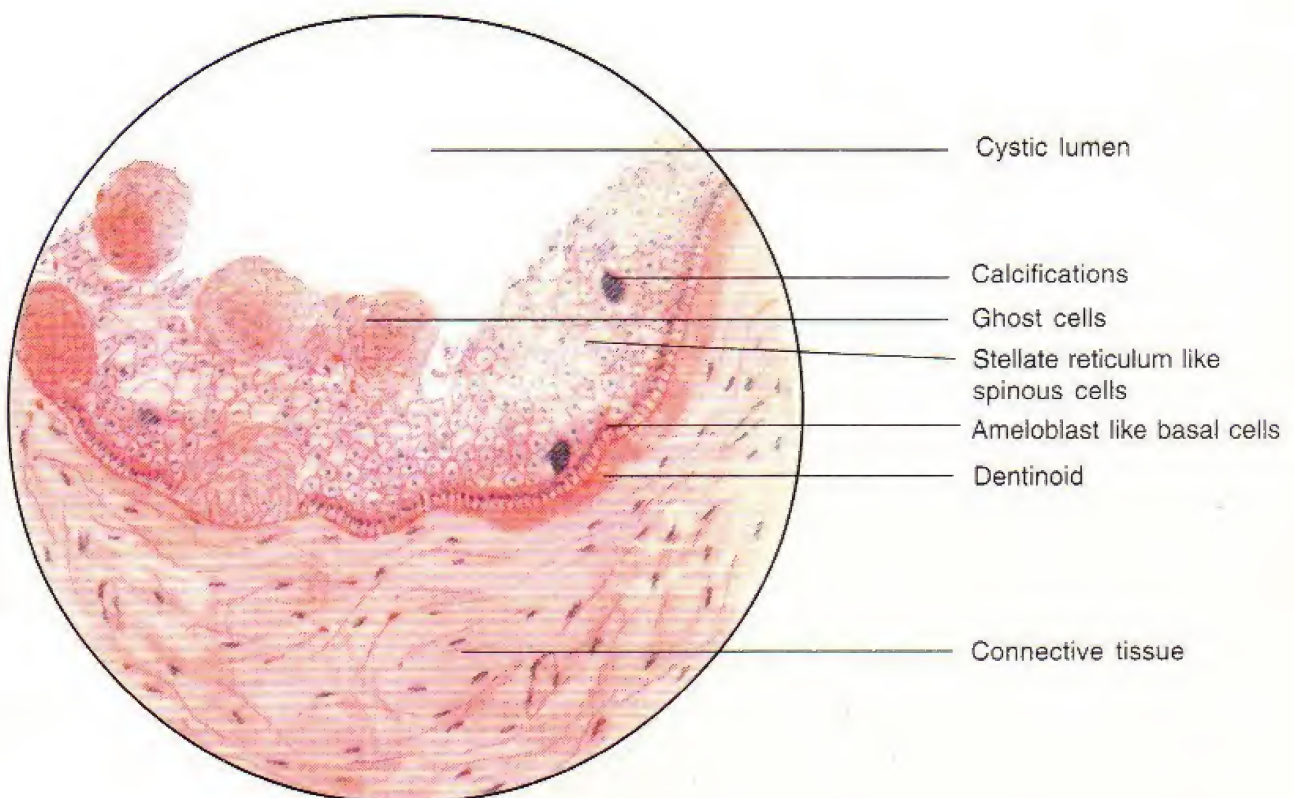


Fig. 12.3 Calcifying odontogenic cyst

degeneration. These cells are seen in thickened areas of lining epithelium. Calcifications may be present which are seen as dystrophic deposits in connection with the ghost cells. Another feature of COC is inductive changes in connective tissue adjacent to lining epithelium as areas of eosinophilic matrix material resembling dentinoid. Connective tissue capsule is often scanty and sometimes contain discrete islands of odontogenic cells.

RADICULAR CYST / PERIAPICAL CYST

Radicular cyst or apical periodontal cyst is an inflammatory odontogenic cyst that develop in the periapical region of a non vital tooth. The source of epithelium is cell rests of Malassez and proliferation is stimulated by inflammation. Radiographic picture shows a well defined radiolucency at the root apex.

Histopathology (Fig. 12.4)

Cystic lumen is filled with fluid containing cholesterol crystals. Lining epithelium is nonkeratinized stratified squamous epithelium of variable thickness. Epithelium shows spongiosis and inflammatory cell infiltration. Proliferating epithelium exhibits characteristic arcading pattern where arcades of epithelium enclosing a densely inflamed connective tissue. Epithelium may also show arc shaped hyaline structures called Rushton bodies. Connective tissue capsule adjacent to lining epithelium is delicate with dense inflammatory cell infiltration. Deeper portion of

connective tissue capsule is more fibrous with relatively less inflammation.

Connective tissue capsule may also show cleft like spaces (Fig. 12. 5) filled with cholesterol that are seen as spindle shaped spaces. The presence of these cholesterol crystals evoke a granulomatous reaction in the connective tissue.

MUCOCELE

(MUCOUS EXTRAVASATION CYST)

This is a common soft tissue cyst, occurring in the oral mucosa due to trauma to the minor salivary duct. Trauma leads to rupture of duct followed by spillage of mucin to the surrounding tissue evoking an inflammatory reaction. Mucocele is seen as a fluctuant dome shaped swelling ranging from 1-8 mm size. This lesion is common on lower lip and patient may give a definite history of trauma.

Histopathology (Fig. 12.6)

Basic feature of mucocele is a pseudocyst with granulation tissue wall. There is no lining epithelium. The lesion shows a central irregular mucin spilled area surrounded by granulation tissue wall. Granulation tissue comprises of delicate collagen bundles, plump fibroblasts, proliferating endothelial cells, budding capillaries and chronic inflammatory cells. Muciphages or mucin-engulfed macrophages are seen in the mucin pooled area and in lining. Adjacent minor salivary gland and a ruptured salivary duct (feeder duct) may be seen.



Identification Points Fig. No. 12.4

RADICULAR CYST

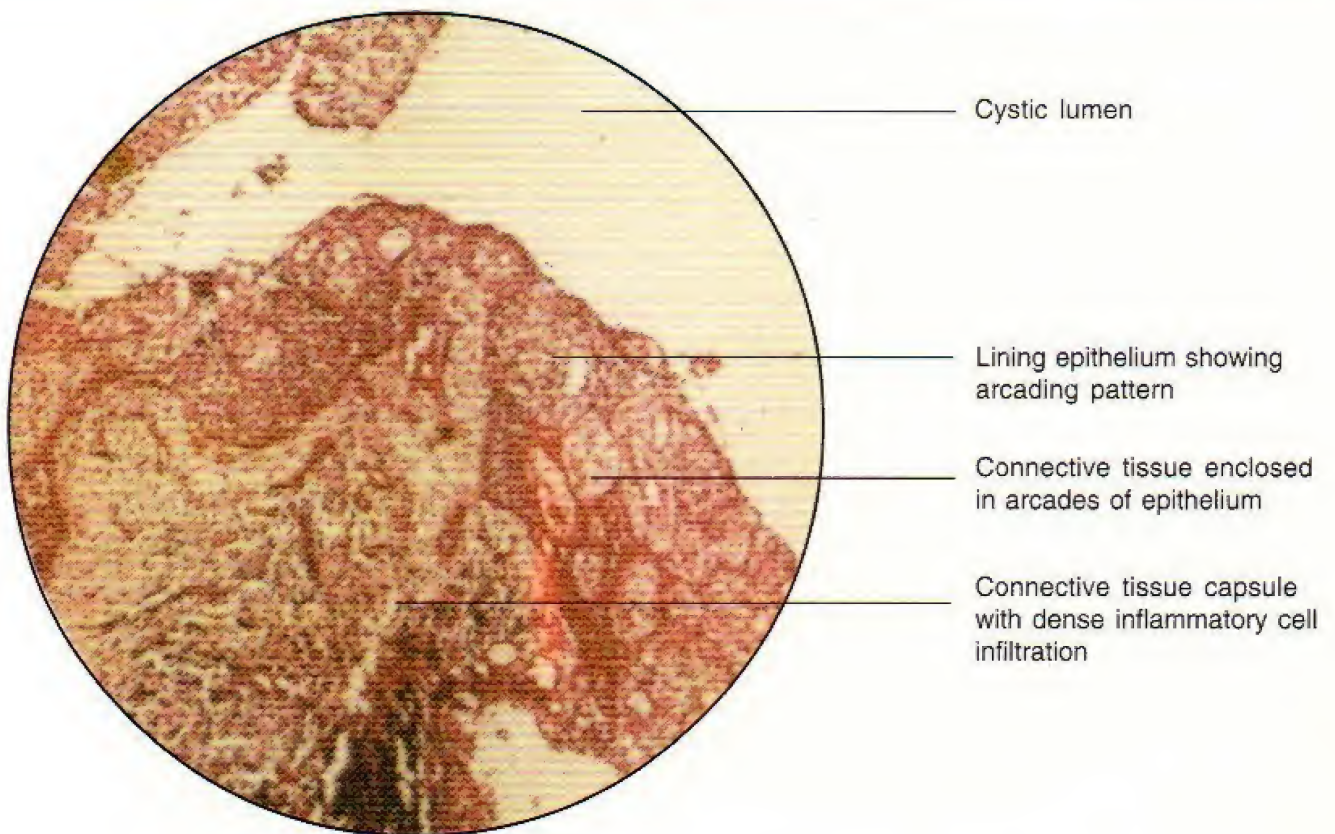
- Non keratinized lining epithelium of variable thickness
- Arcading patterns of epithelium
- Dense inflammation of cystic capsule
- Cholesterol clefts in capsules



Identification Points Fig. No. 12.6

MUCOCELE

- Mucin pooled area
- Granulation tissue wall surrounding mucin
- Presence of mucinophages and inflammatory cells



Radicular cyst (Photomicrograph 10X)

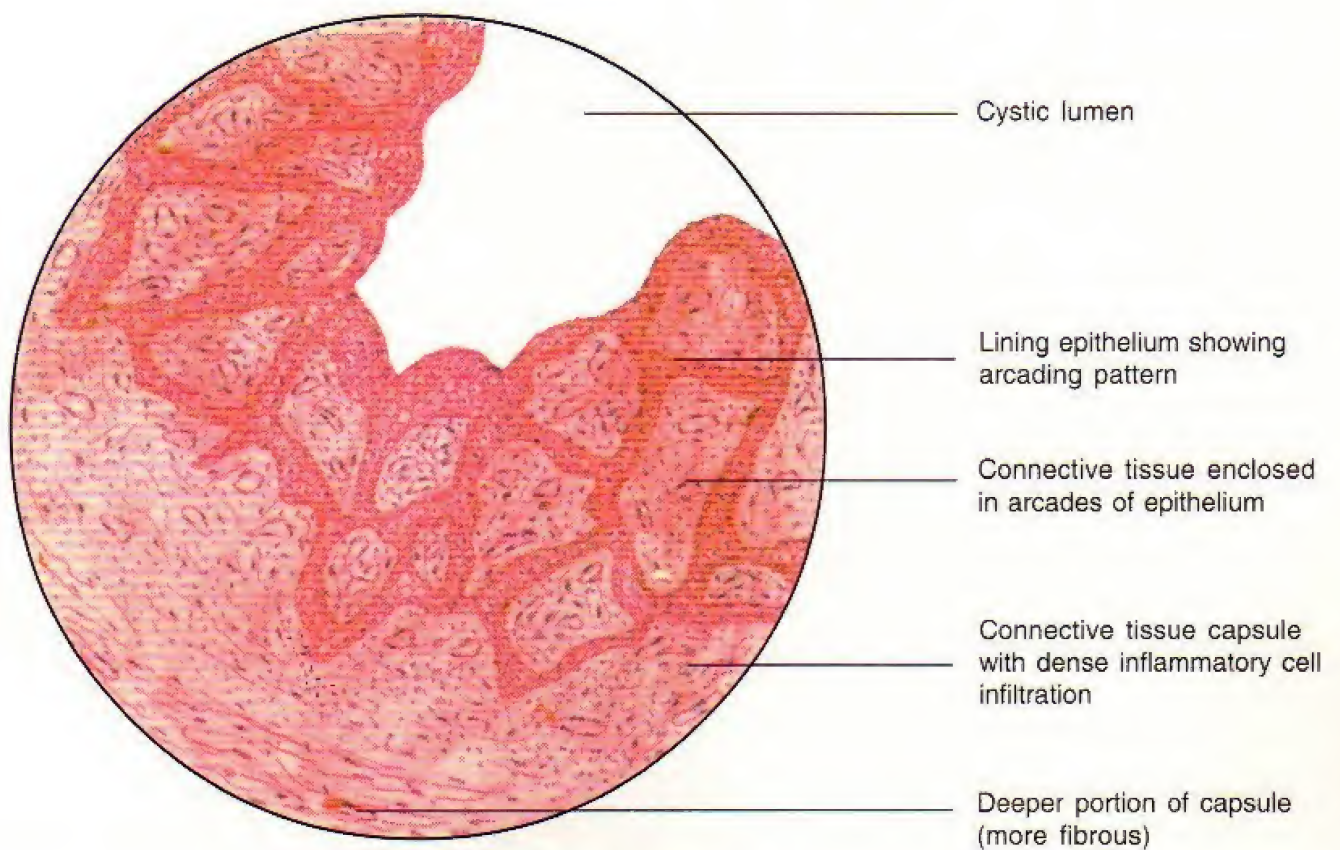
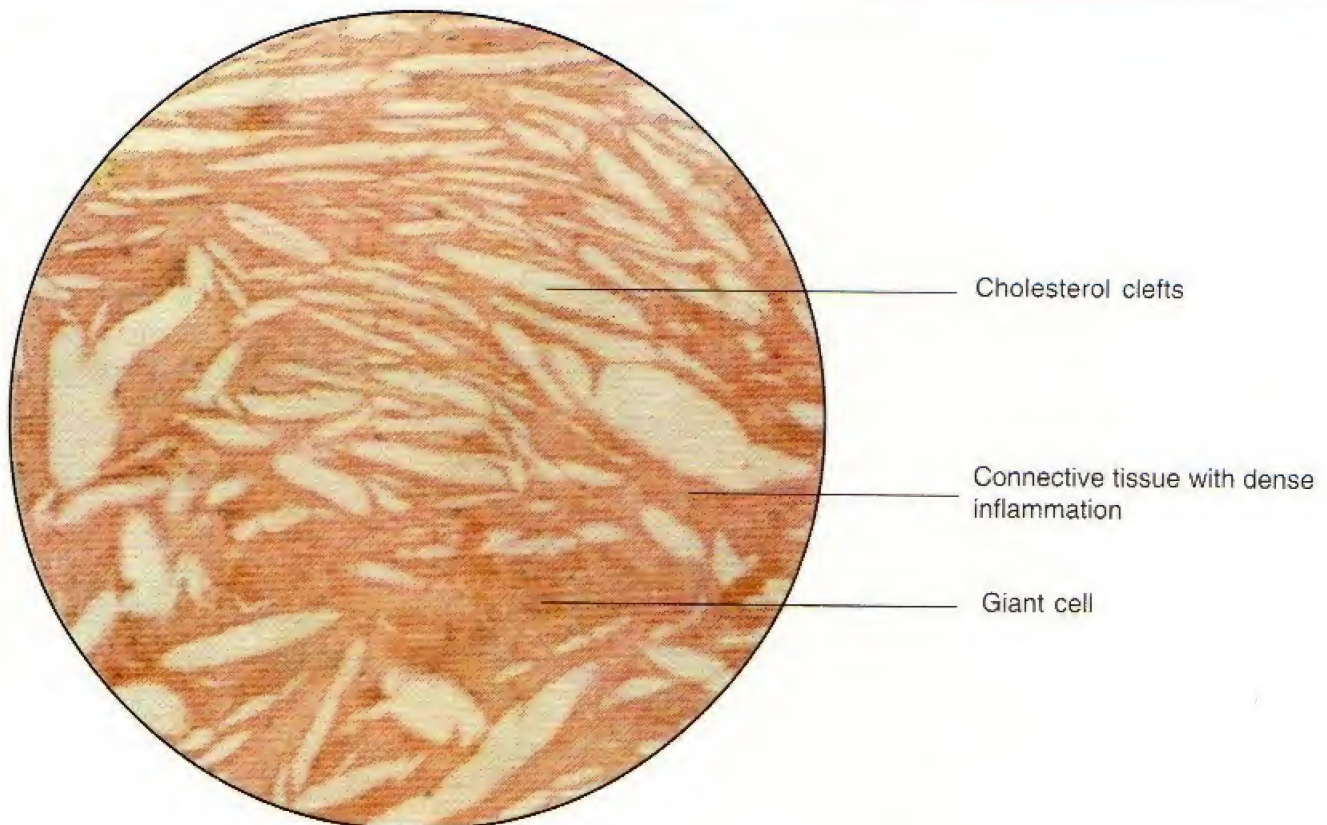


Fig. 12.4 Radicular cyst



Cholesterol clefts in radicular cyst (Photomicrograph 10X)

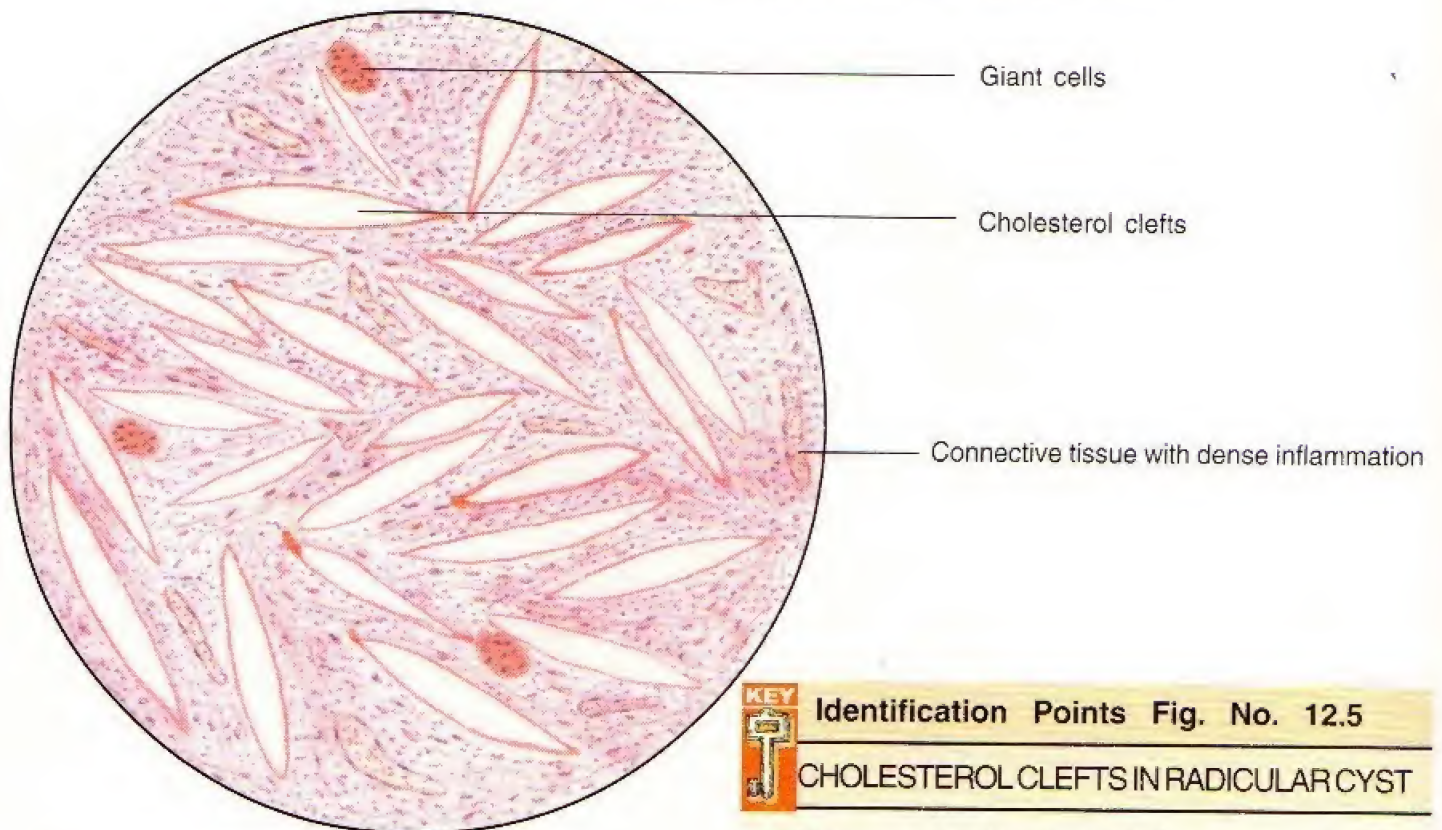


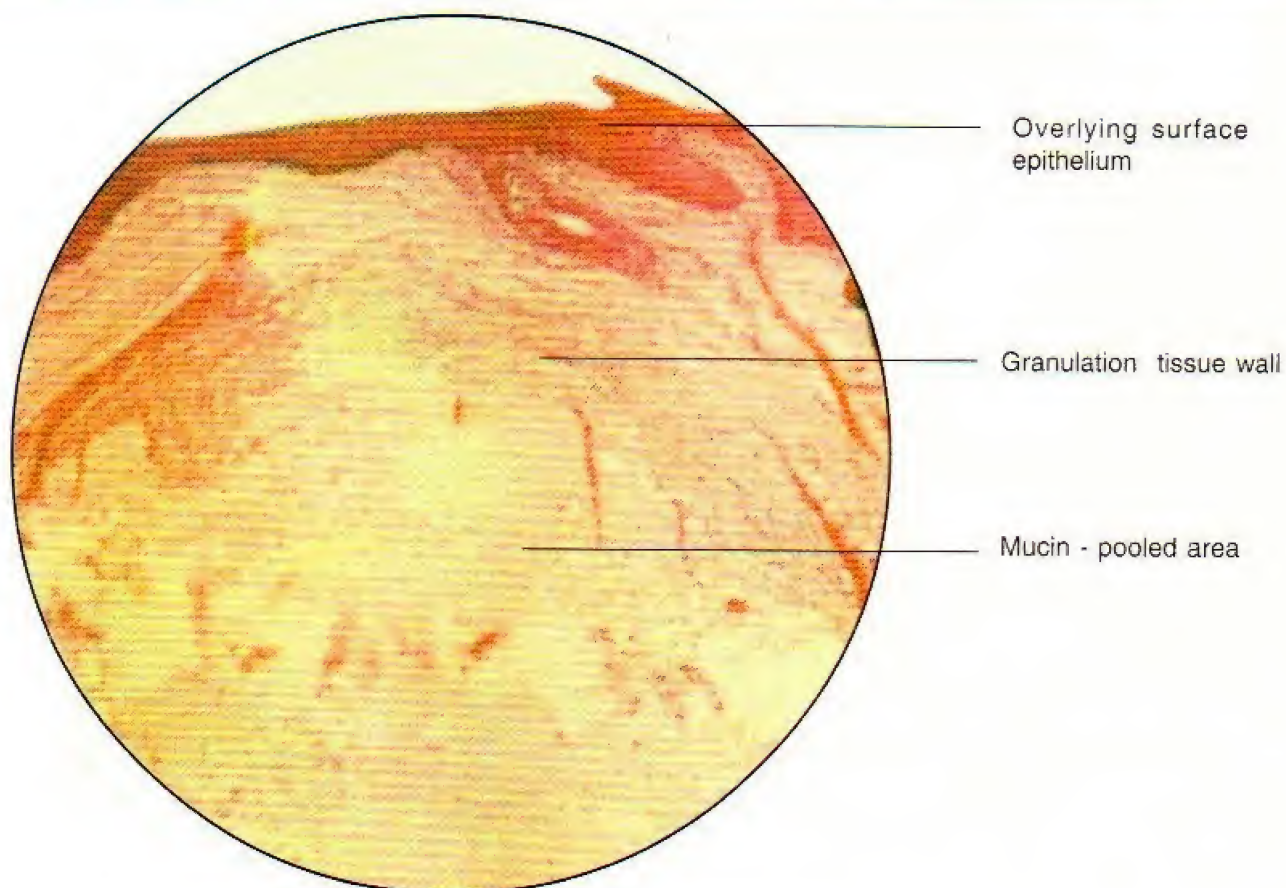
Fig. 12.5 Cholesterol clefts in radicular cyst



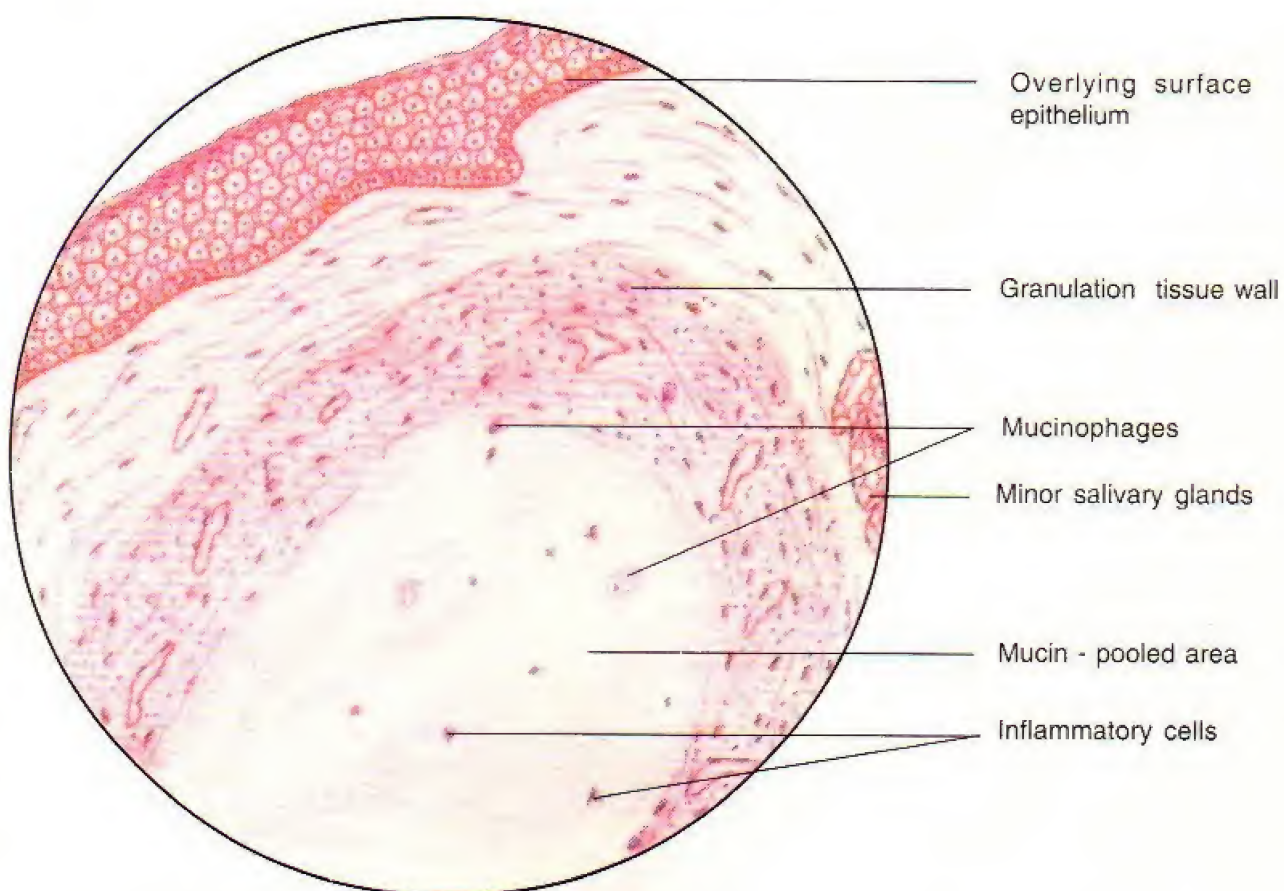
Identification Points Fig. No. 12.5

CHOLESTEROL CLEFTS IN RADICULAR CYST

- Seen as spindle shaped clear spaces in the connective tissue capsule
- Surrounding connective tissue shows granulation tissue reaction



Mucocele (Photomicrograph 10X)



13

Odontogenic Tumors

- Ameloblastoma
 - Follicular
 - Plexiform
 - Acanthomatous
- Adenomatoid odontogenic tumor
- Calcifying epithelial odontogenic tumor
- Central cementifying fibroma

Tumors developing from the odontogenic tissue (any component of tooth germ or its remnants) are called odontogenic tumors. These tumors may develop from epithelial component or ectomesenchymal component, or both (mixed tumors). Based on biological behavior odontogenic tumors can be benign and malignant.

AMELOBLASTOMA

It is a benign epithelial odontogenic tumor mainly affecting the posterior region of mandible. This lesion is initially asymptomatic, slowly progressing to cause bony expansion. Ameloblastoma can grow to massive size and typically present in a radiograph as a multilocular radiolucency described as "honey comb" or "soap bubble" appearance.

Histopathology

Histological variants of ameloblastoma are –

1. **Follicular ameloblastoma (Fig. 13.1):** In this variant, tumor cells are arranged in the form of few follicles distributed in connective tissue stroma. Follicles have a peripheral layer of ameloblast like cells, i.e. columnar cells that have nucleus arranged away from the base of the cells. Central



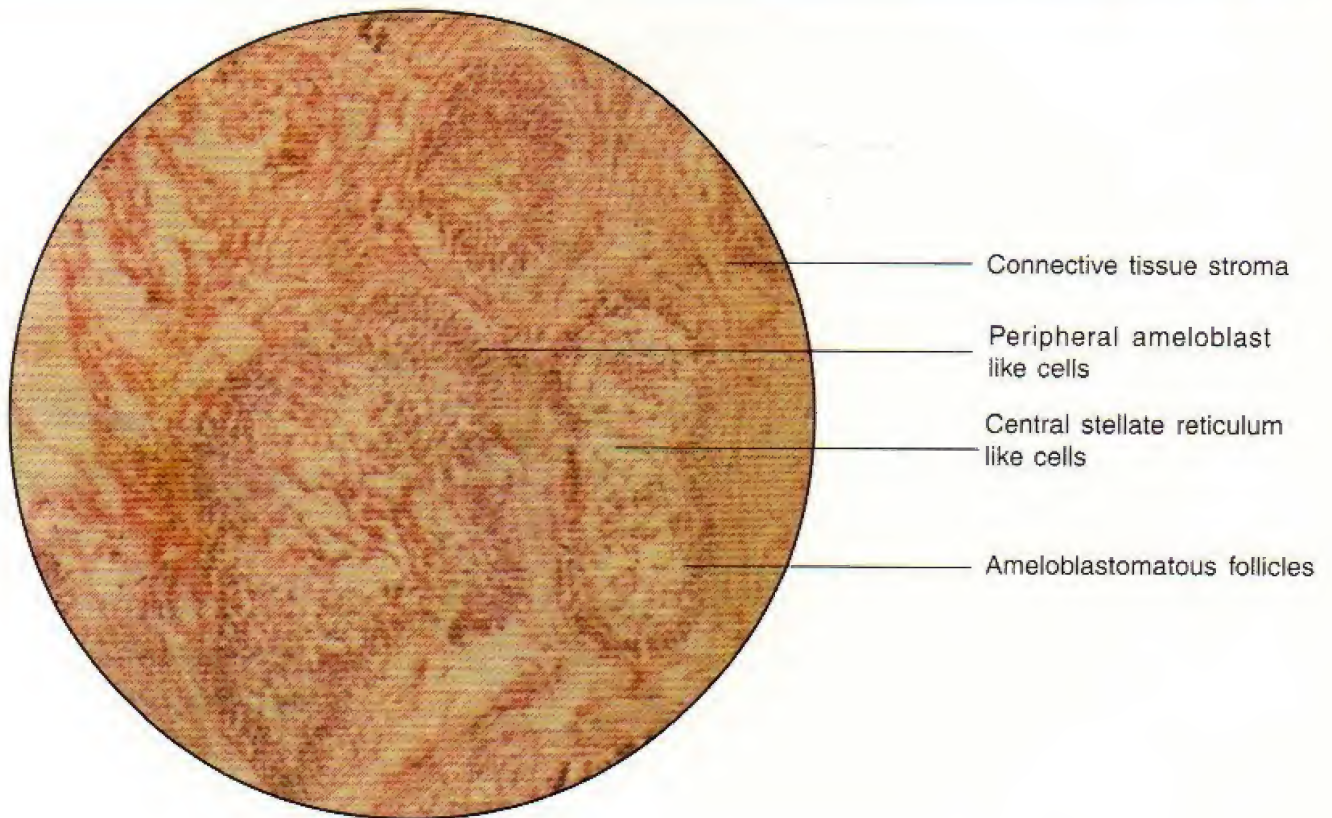
Identification Points Fig. No. 13.1

FOLLICULAR AMELOBLASTOMA

- Odontogenic epithelial cells arranged to form follicles
- Peripheral ameloblast like cells
- Central stellate reticulum like cells
- Intra follicular cyst formation

portion of the follicle has loosely arranged cells resembling stellate reticulum. In this variant, cyst formation can take place within the follicle by the cystic degeneration of stellate reticulum like cells (intra follicular cysts).

2. **Acanthomatous type (Fig. 13.2):** In this



Ameloblastoma - Follicular type (Photomicrograph 10X)

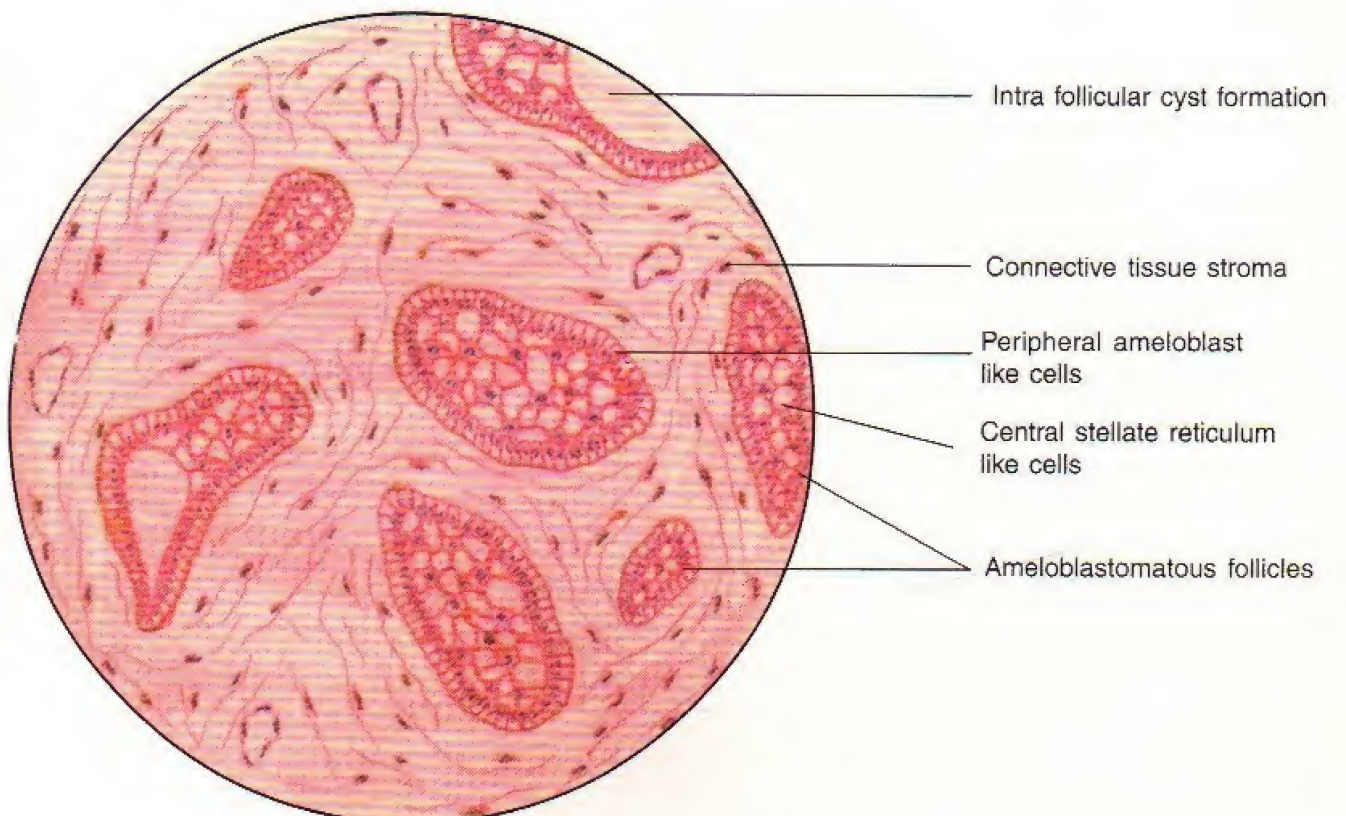
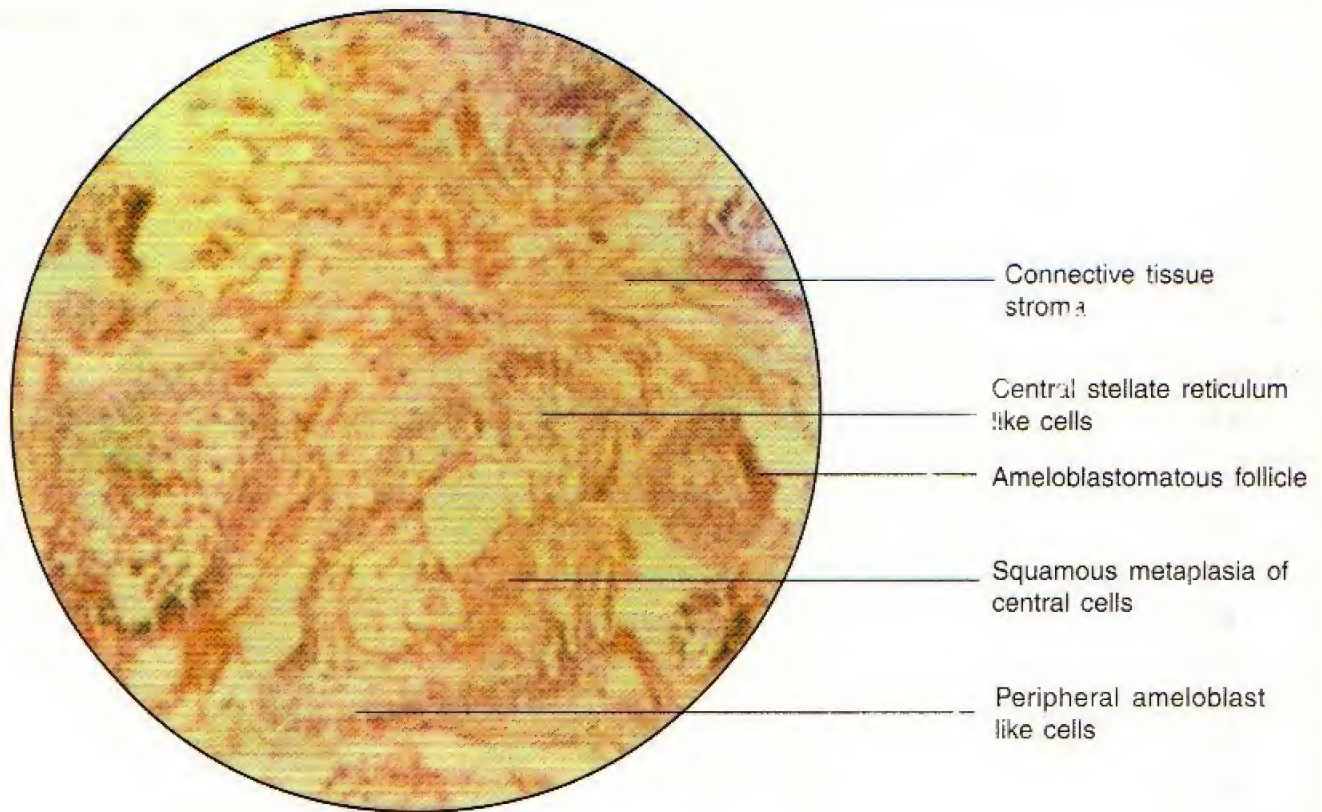


Fig.13.1 Ameloblastoma - Follicular type



Ameloblastoma - Acanthomatous type (Photomicrograph 10X)

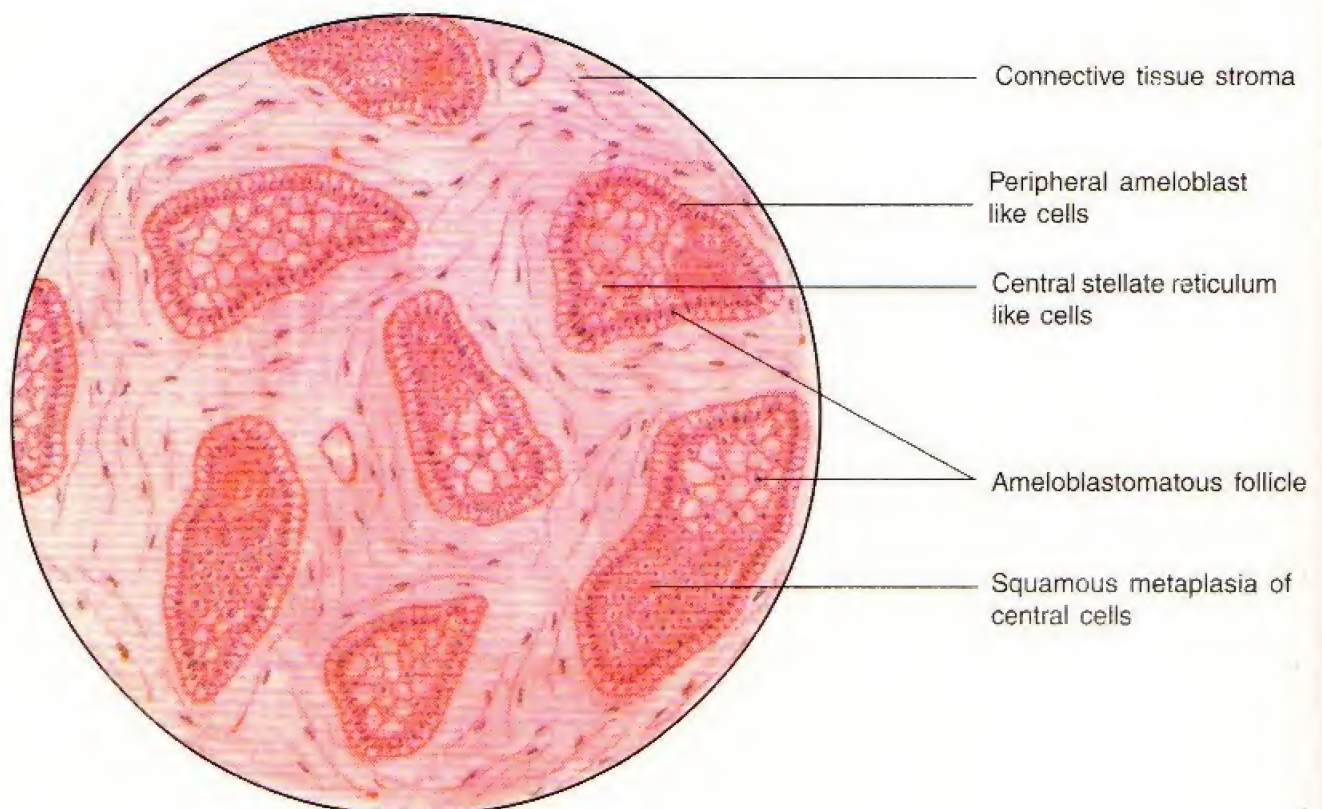


Fig. 13.2 Ameloblastoma - Acanthomatous type


Identification Points Fig. No. 13.2
ACANTHOMATOUS AMELOBLASTOMA

- Odontogenic epithelial cells arranged to form follicles
- Peripheral ameloblast like cells
- Central stellate reticulum like cells
- Squamous metaplasia of stellate reticulum cells in few follicles

histological variant, tumor cells are arranged in the form of follicles with peripheral ameloblast like cells and central stellate reticulum like cells. In some of the follicles the central cells are transformed into squamous cells and may show the evidence of keratinization.

3. **Plexiform Ameloblastoma** (Fig. 13.3): In this pattern, ameloblast like cells are arranged in the form of long anastomosing cords or as irregular strands. These strands are bounded by ameloblast like cells on either side having back to back arrangement with stellate reticulum like cells in between. Stellate reticulum cells are less prominent than in follicular pattern. Connective tissue stroma is seen enclosed between the networks of odontogenic epithelial cells. Cystic degeneration may be observed within the stroma (stromal cysts).


Identification Points Fig. No. 13.3
PLEXIFORM AMELOBLASTOMA

- Strands of odontogenic epithelial cells forming a net work
- Ameloblast like cells have back to back arrangement
- Scanty stellate reticulum like cells
- Stromal cyst formation

Other histological types are **granular cell ameloblastoma**, **basal cell ameloblastoma**, **desmoplastic ameloblastoma**.

**CALCIFYING EPITHELIAL
ODONTOGENIC TUMOR
(PINDBORG'S TUMOR)**

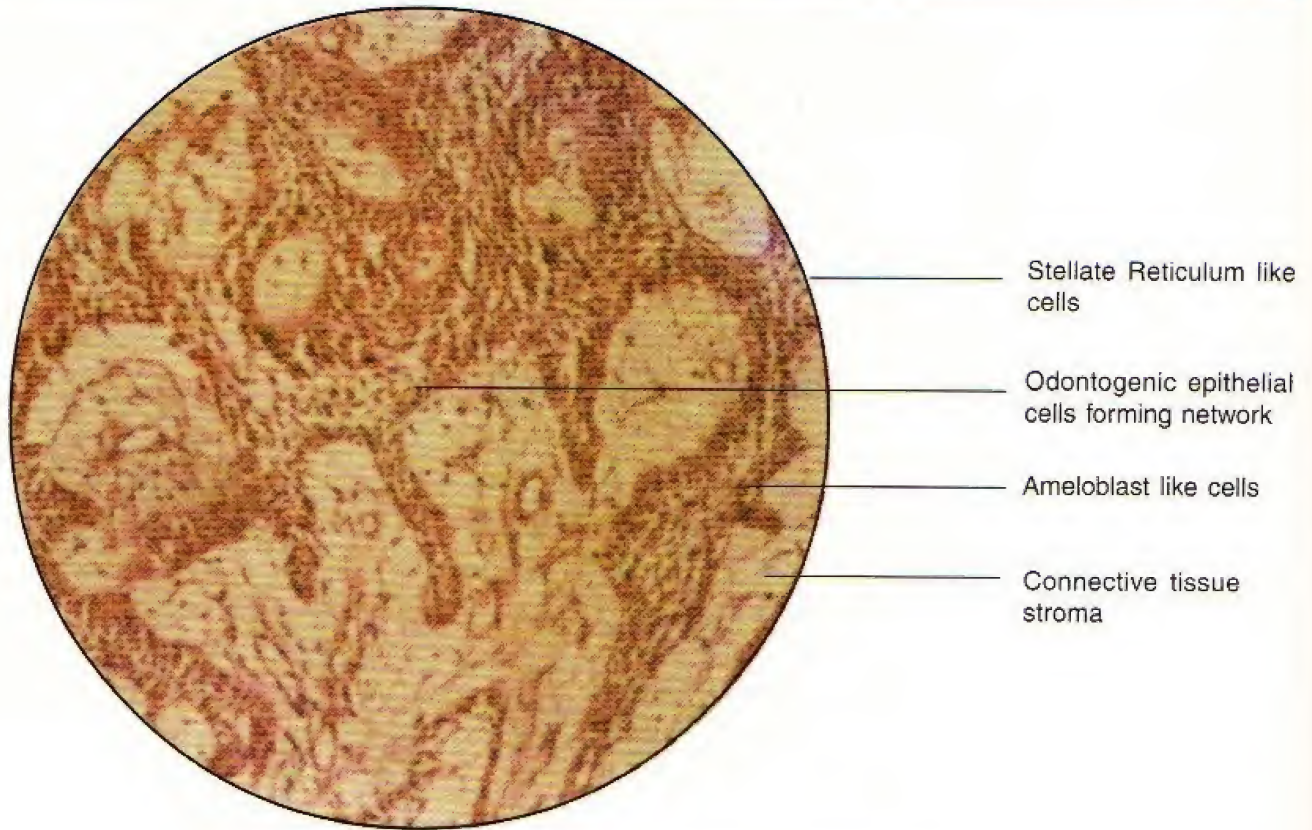
This benign epithelial odontogenic tumor is first described by Pindborg, so it is also called as Pindborg's tumor. Clinically Pindborg's tumor may occur as extraosseous lesions manifesting as gingival swelling, or as intra osseous lesions. In intra osseous lesions present as asymptomatic slowly growing tumor of jaw bone, causing facial asymmetry. Radiographically this tumor shows 'driven snow' appearance.

Histopathology (Fig. 13.4)

Calcifying epithelial odontogenic tumor is composed of sheets or islands of polyhedral odontogenic epithelial cells. These cells have distinct cellular outline and prominent inter cellular bridges. The nuclei of these cells may show variation in size and shape, although mitotic figures are rare. The epithelial component encloses a homogeneous, eosinophilic amyloid like material. Another characteristic feature of Pindborg's tumor is calcifications that may be in the form of concentric rings called 'Liesegang ring' of calcification.


Identification Points Fig. No. 13.4
PINDBORG'S TUMOR

- Sheets of polyhedral cells with prominent intercellular bridges
- Nucleus shows pleomorphism
- Eosinophilic, amyloid like material among the cells
- Calcifications in the form of 'Liesegang ring'.



Ameloblastoma - plexiform type (Photomicrograph 10X)

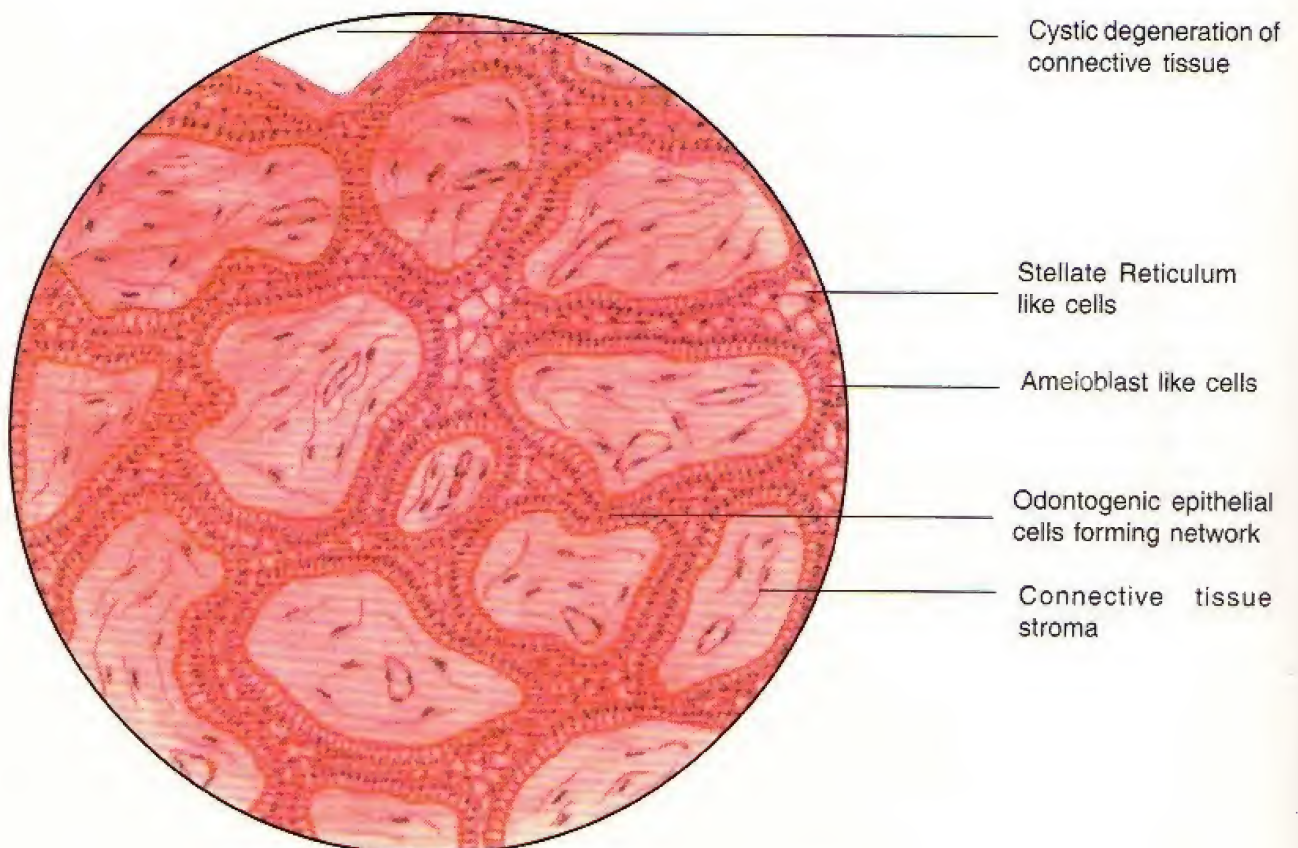
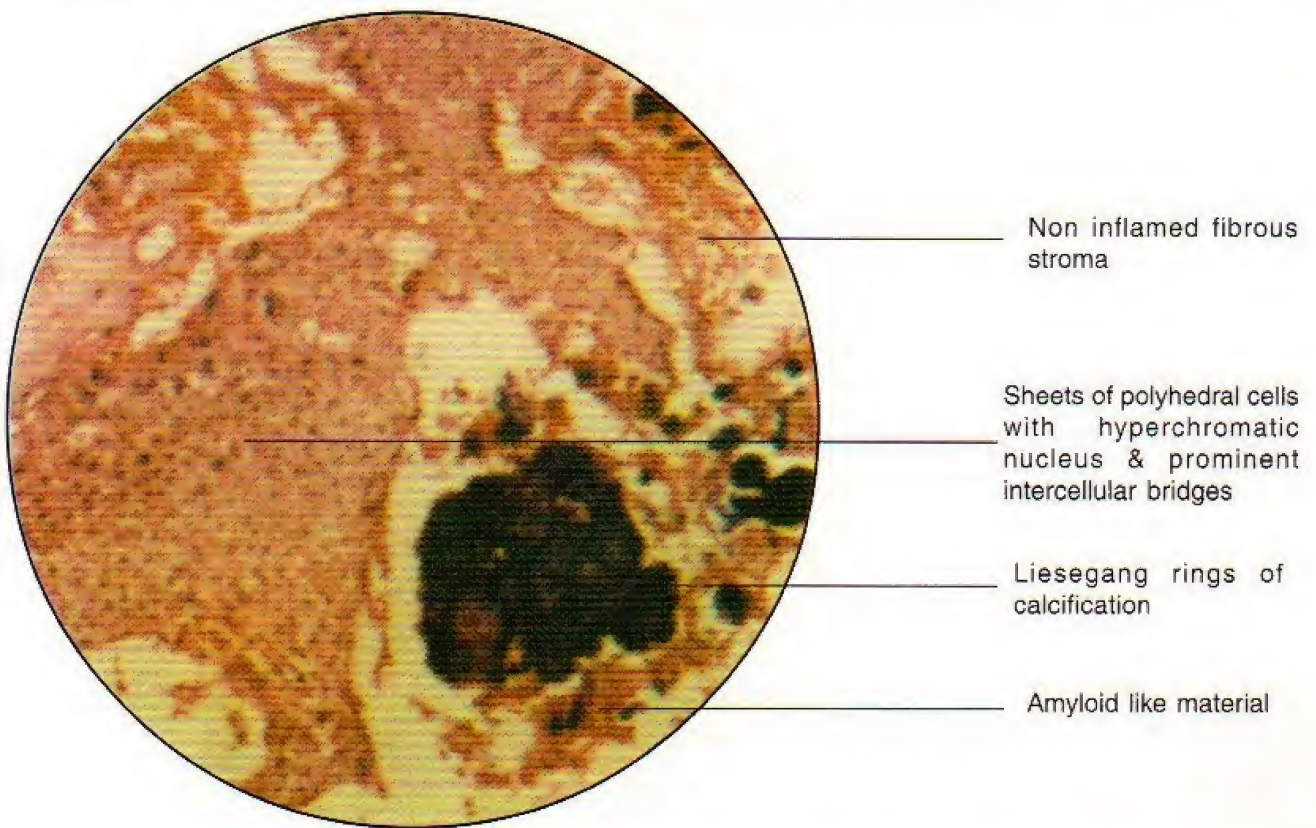


Fig 13.3 Ameloblastoma - plexiform type



Calcifying epithelial odontogenic tumor (Photomicrograph 10X)

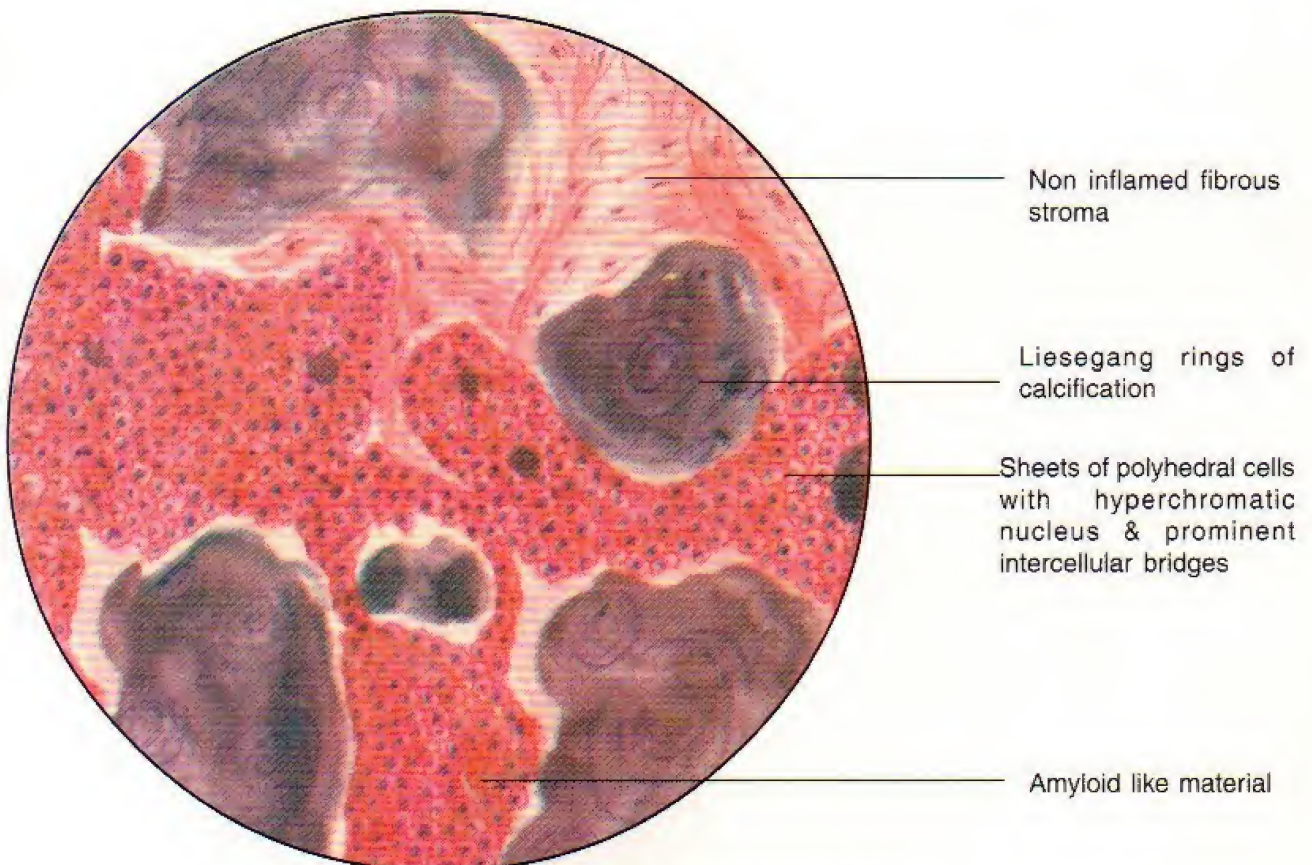


Fig 13.4 Calcifying epithelial odontogenic tumor

Connective tissue is bland and fibrous in nature.

ADENOMATOID ODONTOGENIC TUMOR

This is a benign epithelial odontogenic tumor which occurs commonly in the anterior region of maxilla, and present as asymptomatic lesion which may gradually produce facial asymmetry.

Histopathology (Fig. 13.5)

AOT is composed of epithelial cells, polyhedral or spindle shaped or ameloblast like cells arranged to form different patterns like island, sheets, strands, whorled mass, rosettes, duct like pattern or convoluted pattern. One of the characteristic feature of this tumor is duct like or tubular arrangement of ameloblast like cells (therefore the name adenomatoid odontogenic tumor). The ameloblast like cells have nucleus arranged at the periphery away from the central space. The central space may contain eosinophilic material. Amorphous eosinophilic

material also may be found in the midst of cells arranged as nests. Foci of calcification also may be scattered through out the tumor. Connective tissue is scanty.

CENTRAL CEMENTIFYING FIBROMA

Central cementifying fibroma is a benign tumor of odontogenic mesenchymal origin. This lesion is considered as a fibro-osseous lesion. Clinically this tumor present as a central lesion of the bone that enlarges to cause facial asymmetry and displacement of the teeth.

Histopathology (Fig. 13.6)

Central cementifying fibroma is composed of highly cellular connective tissue that has large number of plump fibroblasts and cementoblasts. Foci of basophilic calcification (cementum like material) is scattered in this stroma. Calcifications may be round, ovoid or slightly irregular in shape. In mature lesions these cementum like materials fuse to form large mass. Some lesions may also show few bony trabeculae along with cementum like material. Such lesions are called cemento-ossifying fibromas.



Identification Points Fig. No.13.5

ADENOMATOID ODONTOGENIC TUMOR

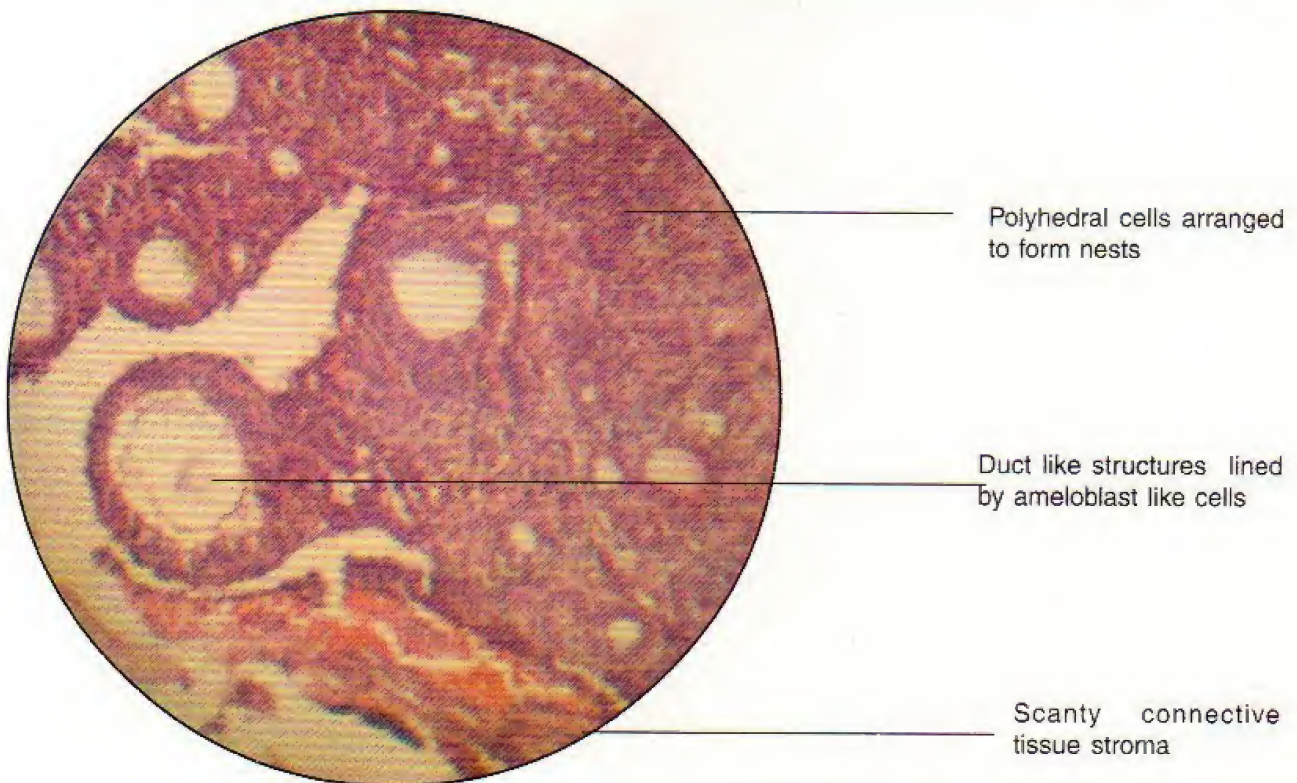
- Cells arranged in various patterns like strands, sheets, island etc.
- Ameloblasts like cells arranged to form duct like pattern
- Amyloid like material in the midst of cells
- Presence of scattered calcifications



Identification Points Fig. No.13.6

CENTRAL CEMENTIFYING FIBROMA

- Highly cellular connective tissue
- Scattered cementum like material in the stroma



Adenomatoid odontogenic tumor (Photomicrograph 10X)

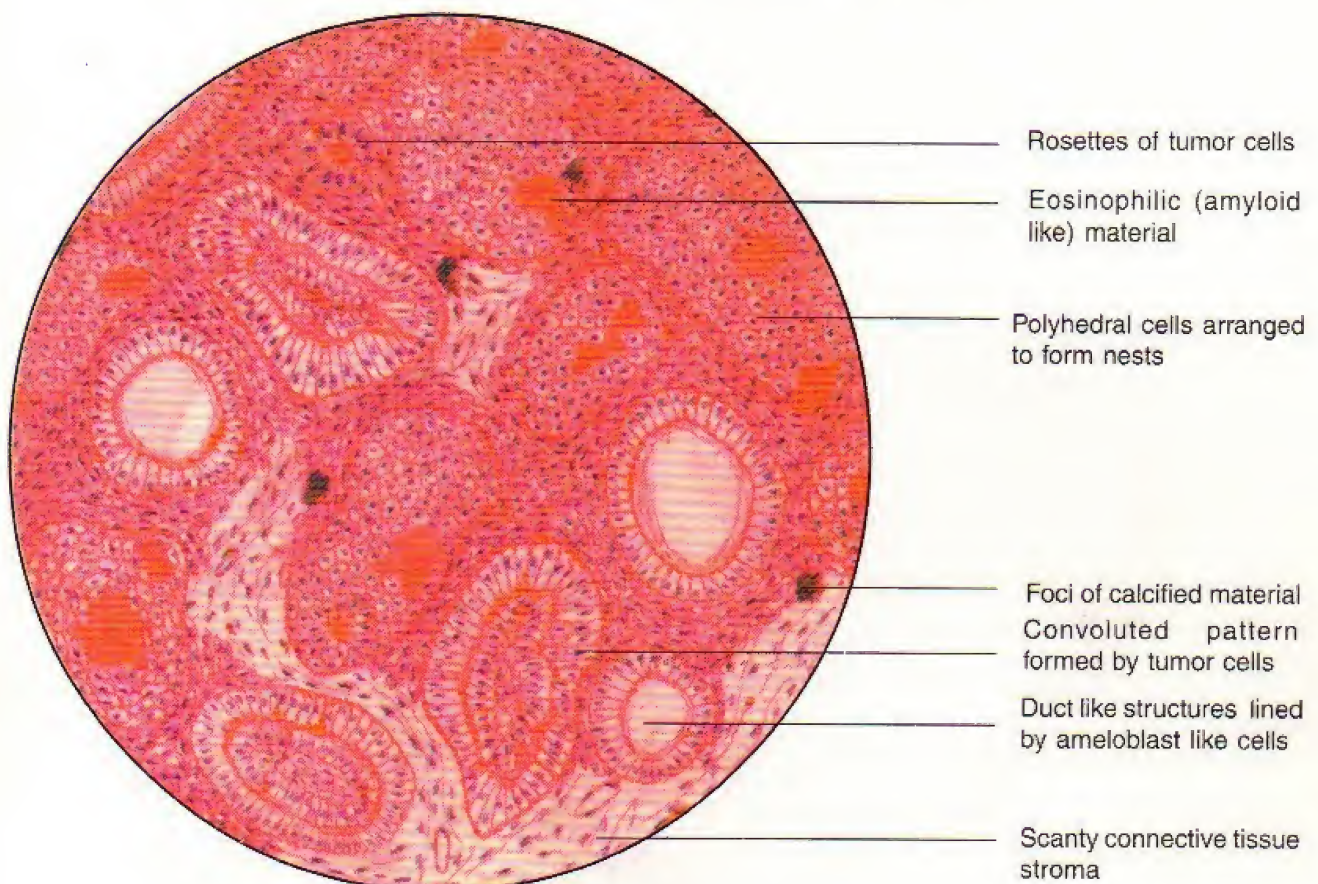
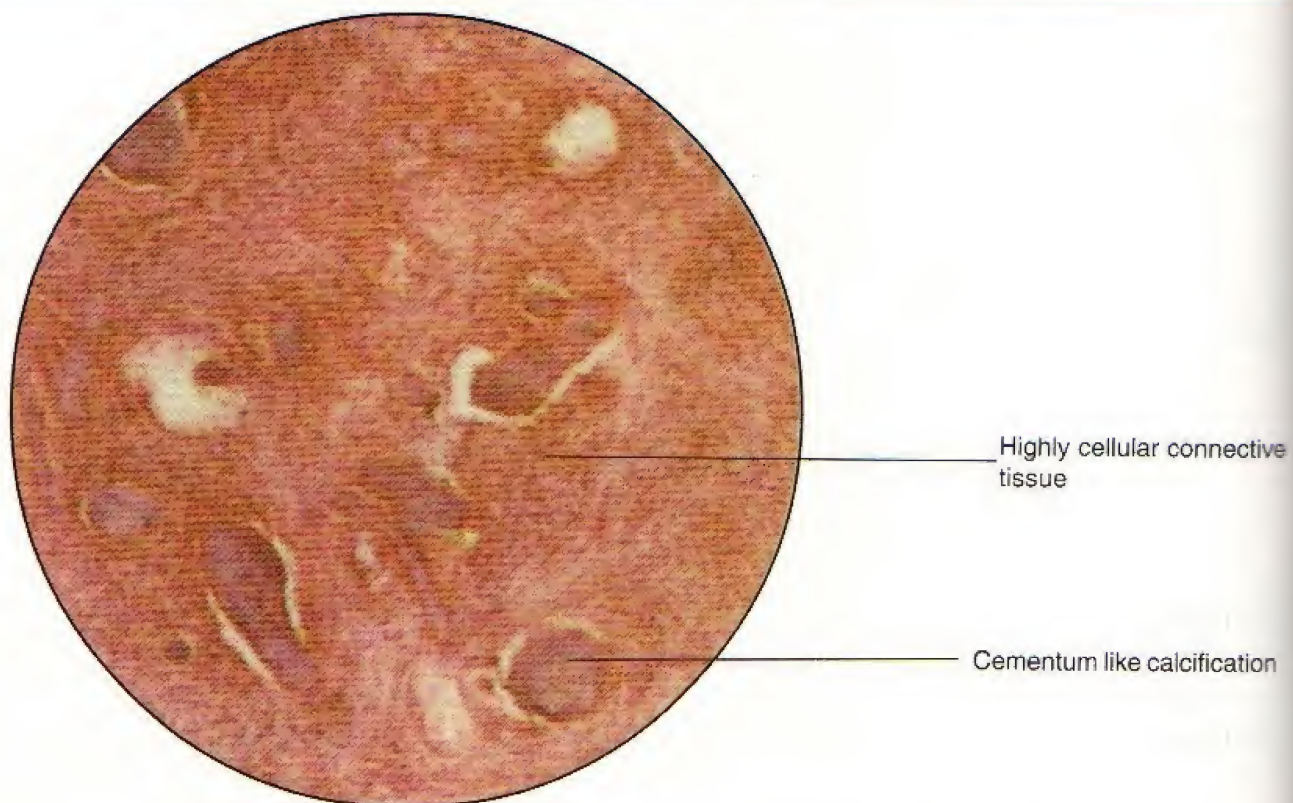


Fig. 13.5 Adenomatoid odontogenic tumor



Central cementifying fibroma (Photomicrograph 10X)

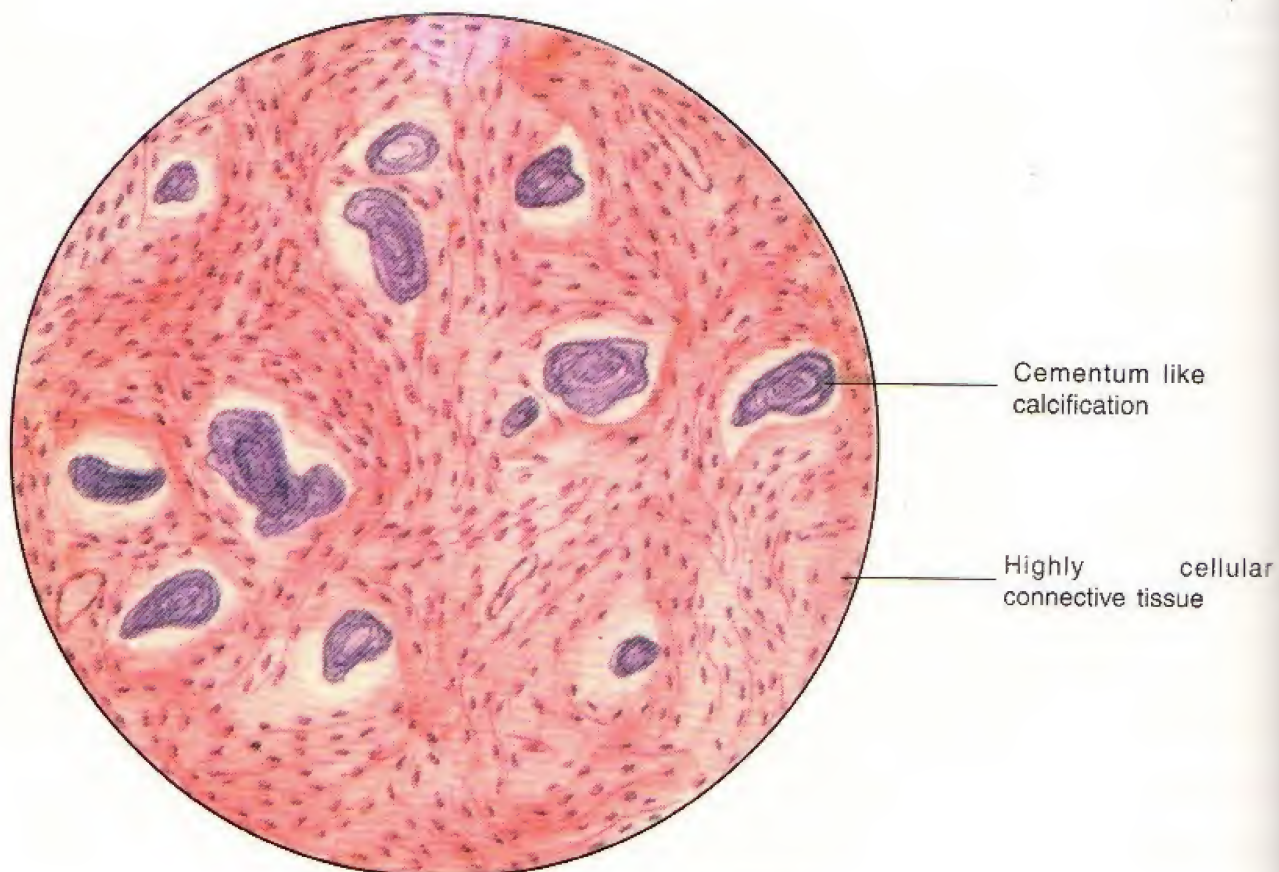


Fig. 13.6 Central cementifying fibroma

Dental Caries

- Enamel caries
 - Pit and Fissure
 - Smooth surface
- Dentine caries

Dental caries is an irreversible, infectious, microbial disease affecting the hard tissue portion of the tooth exposed to the oral cavity, characterized by demineralization of inorganic components and destruction of organic components, resulting in cavitation.

ENAMEL CARIES

In enamel, caries process may start in the pits and fissures or in the smooth surface.

Caries in pit and fissures spread in a triangular pattern with the base towards the dentinoenamel junction and apex towards the surface. In smooth surface caries although the spread follows a triangular pattern the base is towards the surface of the enamel and the apex towards the dentinoenamel junction.

Histopathology

Microscopically both pit and fissure (Fig. 14.1)



Identification Points Fig. No.14.1

ENAMEL CARIES (PIT & FISSURE)

- Triangular in shape with base towards DEJ & apex towards the surface
- Four zones are seen - Translucent zone, dark zone, body of the lesion and surface zone
- Striae of Retzius is prominent in the body of lesion

and smooth surface enamel caries (Fig. 14.2) shows four zones.

- **Translucent zone** – This zone is the inner most zone at the advancing end of the caries. This zone is not always present
- **Dark zone**- is the zone immediately above the translucent zone and this appears slightly dark in the section. Dark zone is always present and shows positive birefringence under polarized light.
- **Body of the lesion**- This zone occupies the major portion of the caries lesion and this is the area of maximum demineralization. In this zone striae of Retzius appear more prominent.

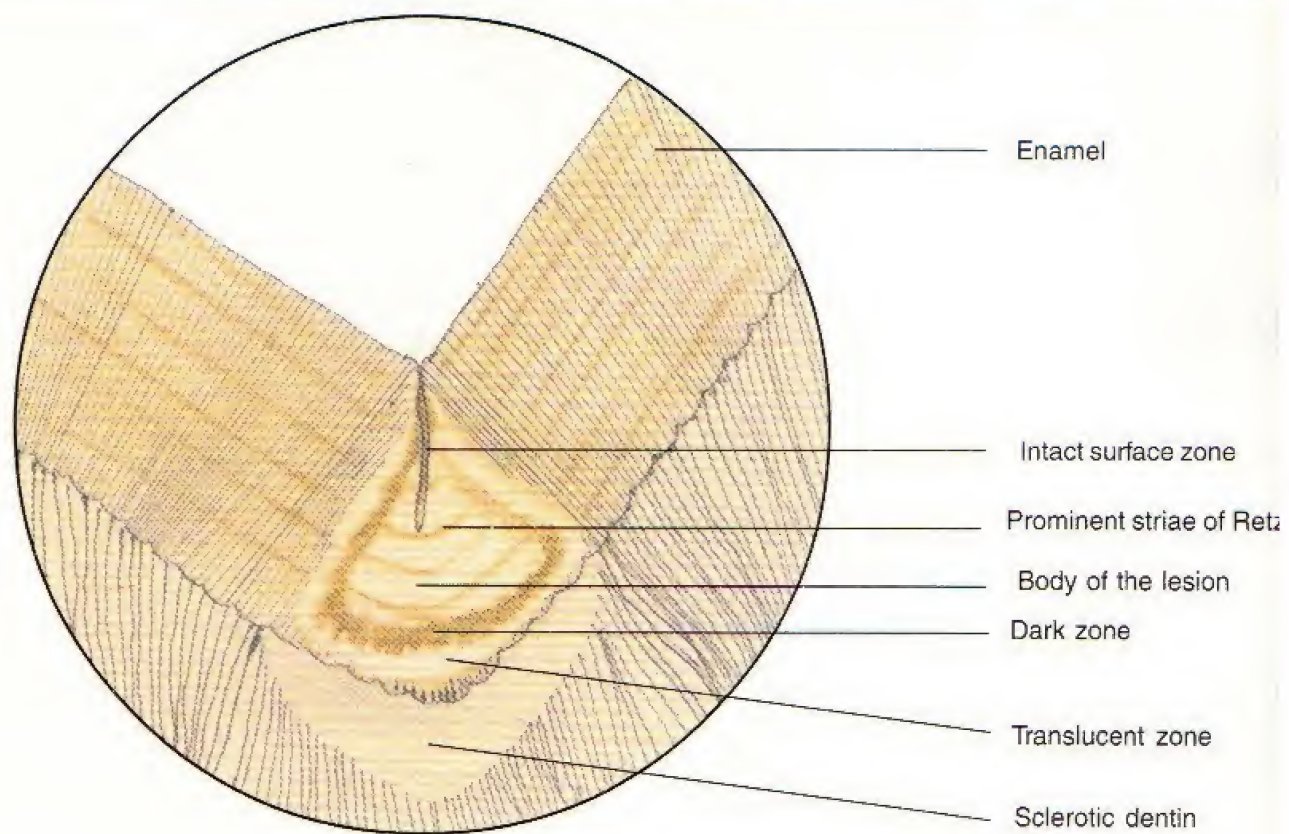


Fig.14.1 Enamel caries (Pit and Fissure - ground section)

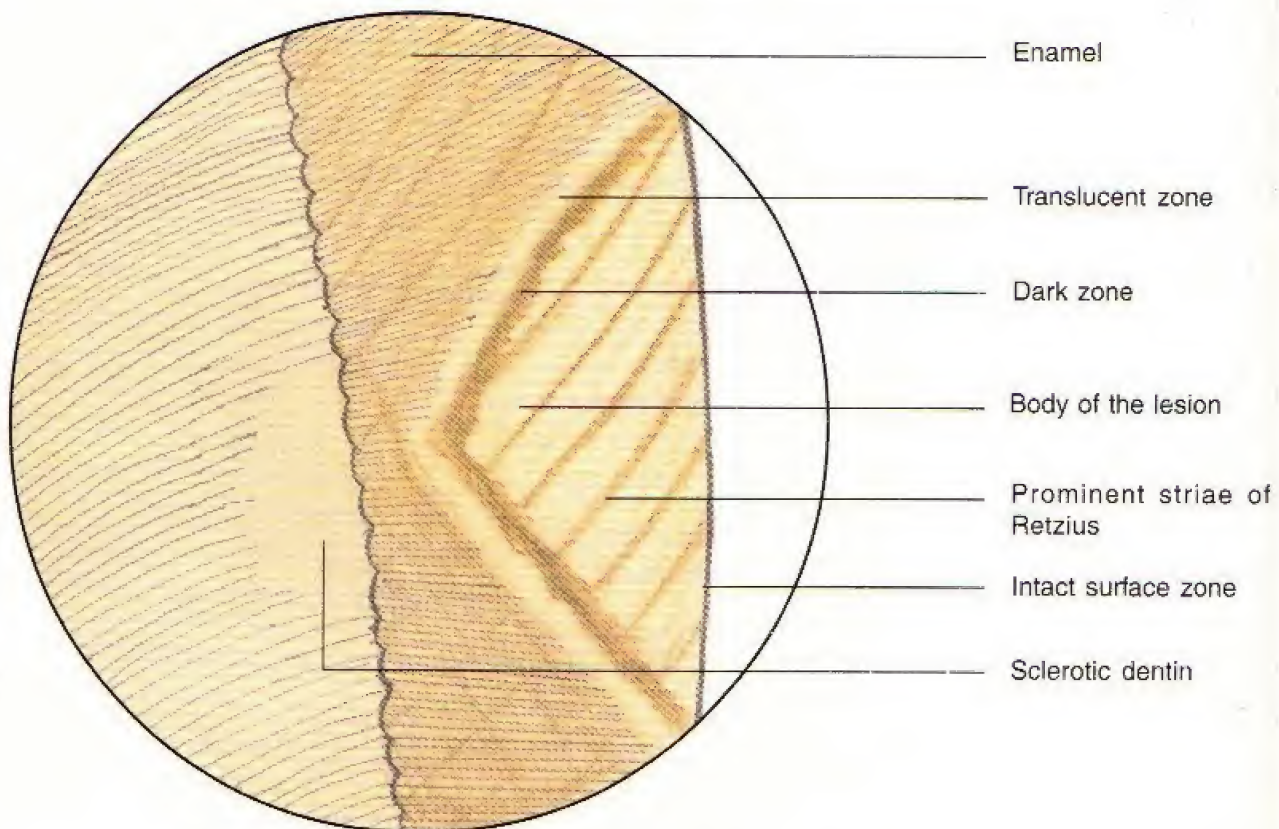


Fig.14. 2 Enamel caries (Smooth surface - ground section)



Identification Points Fig. No.14.2

ENAMEL CARIES (SMOOTH SURFACE)

- Triangular shape with base towards the surface & apex towards DEJ
 - Four zones are seen; - Translucent zone, dark zone, body of the lesion and surface zone
 - Striae of Retzius is prominent in the body of lesion
-
- **Surface zone-** This is the intact zone of 40 microns thickness at the surface of enamel caries lesion.

DENTINAL CARIES

Once the caries process spreads to dentine the microorganisms invade the dentinal tubules and

release acids. The spread of caries follows a triangular pattern with the base towards the dentinoenamel junction and apex towards the pulp. Apex will be located more apical to the base.

Histopathology (Fig. 14.3)

Microscopically five different zones are seen.

- Zone of fatty degeneration of Tomes' dentinal fibers is the initial change seen at the advancing front of dentinal caries near the pulpal surface. In this zone deposition of fat globules are seen in the odontoblast process.
- Translucent zone where the dentinal tubules are sclerosed.
- Zone of demineralization in which the dentin shows decalcification without evidence of bacterial invasion.

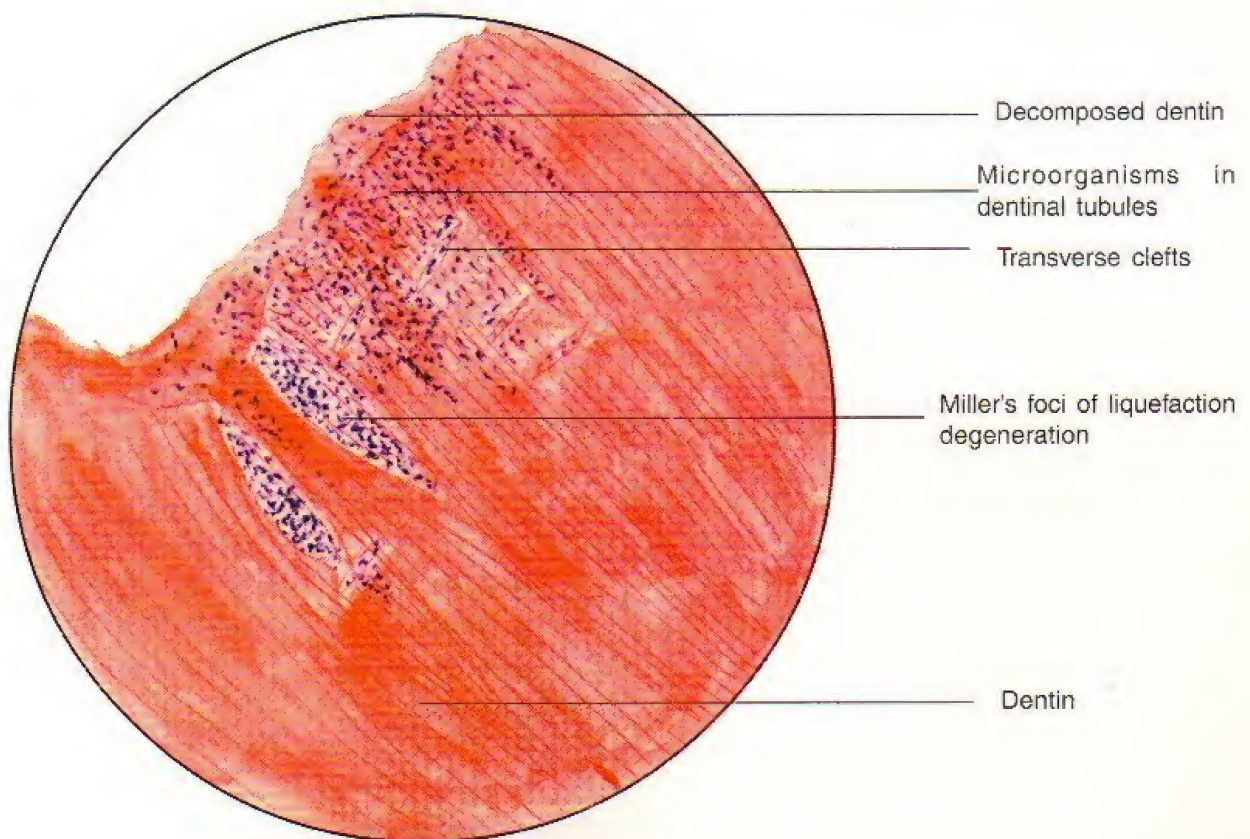


Fig.14.3 Dentinal caries (decalcified section)

**Identification Points Fig. No. 14.3****DENTINAL CARIES**

Five zones are seen

- Zone of fatty degeneration
- Zone of dentinal sclerosis
- Zone of demineralization
- Zone of bacterial invasion
- Zone of decomposed dentin

- Zone of bacterial invasion- In this zone dentin is intact but shows dense bacterial invasion of dentinal tubules. The walls of

dentinal tubules are softened due to demineralization and get distorted by the dense packing of microorganisms. The resulting elliptical shaped areas parallel to the dentinal tubules are called 'Miller's foci of liquefaction degeneration. Lateral spread of organisms through the lateral branches of dentinal tubules results in formation of 'transverse clefts' which are perpendicular to the tubules.

- Zone of decomposed dentin- This is the most superficial layer of dentinal caries where the architecture of dentin is lost due to bacterial destruction.

15

Pulp and Periapical Lesions

- Pulpal hyperemia
- Pulp abscess
- Pulp polyp
- Periapical granuloma

Pulp is vital tissue and it responds to bacterial infection or any other stimulus by an inflammatory reaction. Inflammation of pulp is called pulpitis and this can be acute or chronic, may involve focal area (partial or focal pulpitis) or most of the pulp tissue (total or generalized pulpitis).

PULP HYPEREMIA (FOCAL REVERSIBLE PULPITIS)

This is the earliest form of pulpitis. This condition is also called reversible pulpitis because the changes are reversible if irritants are removed before the pulp is severely damaged. The affected tooth is sensitive to thermal stimulus which disappears after the removal of the stimulus.

Histopathology (Fig. 15.1)

Characteristic microscopic feature is multiple



Identification Points Fig. No.15.1

PULP HYPEREMIA

- Multiple dilated capillaries filled with RBCs
- Edematous changes in the pulp tissue
- Presence of inflammatory cells

dilated blood vessels filled with RBCs. Pulp may also show edematous changes, extravasation of RBCs and few inflammatory cells.

ACUTE PULPITIS (PULP ABSCESS)

Acute pulpitis may be a sequel to focal reversible pulpitis or due to acute exacerbation of chronic pulpitis. This condition is associated with severe lancinating pain. Tooth is sensitive to thermal changes which persists even after the removal of the stimulus.

Histopathology (Fig. 15.2)

Microscopically acute pulpitis is characterized by infiltration of polymorphs in the pulpal tissue. There may be localized destruction of pulpal

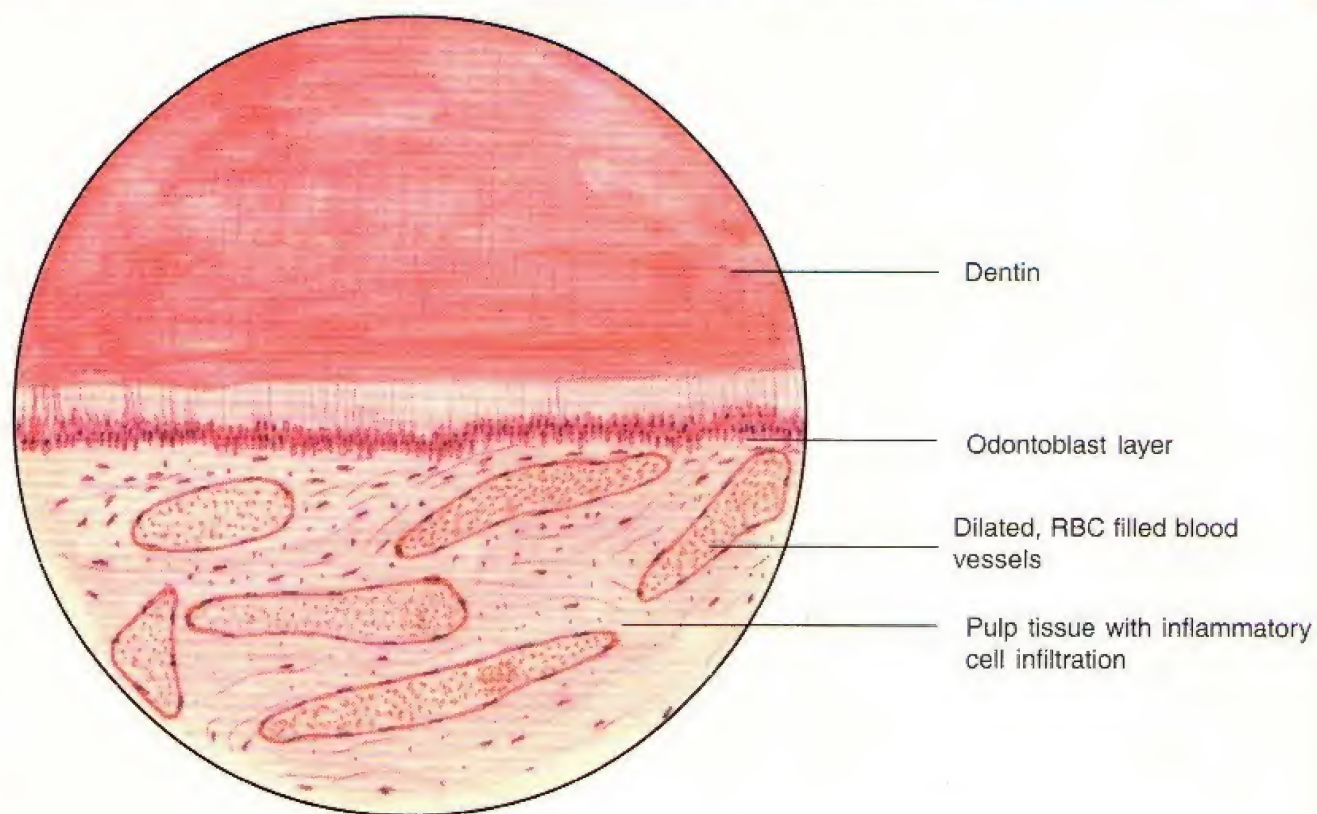


Fig. 15.1 Pulp hyperemia

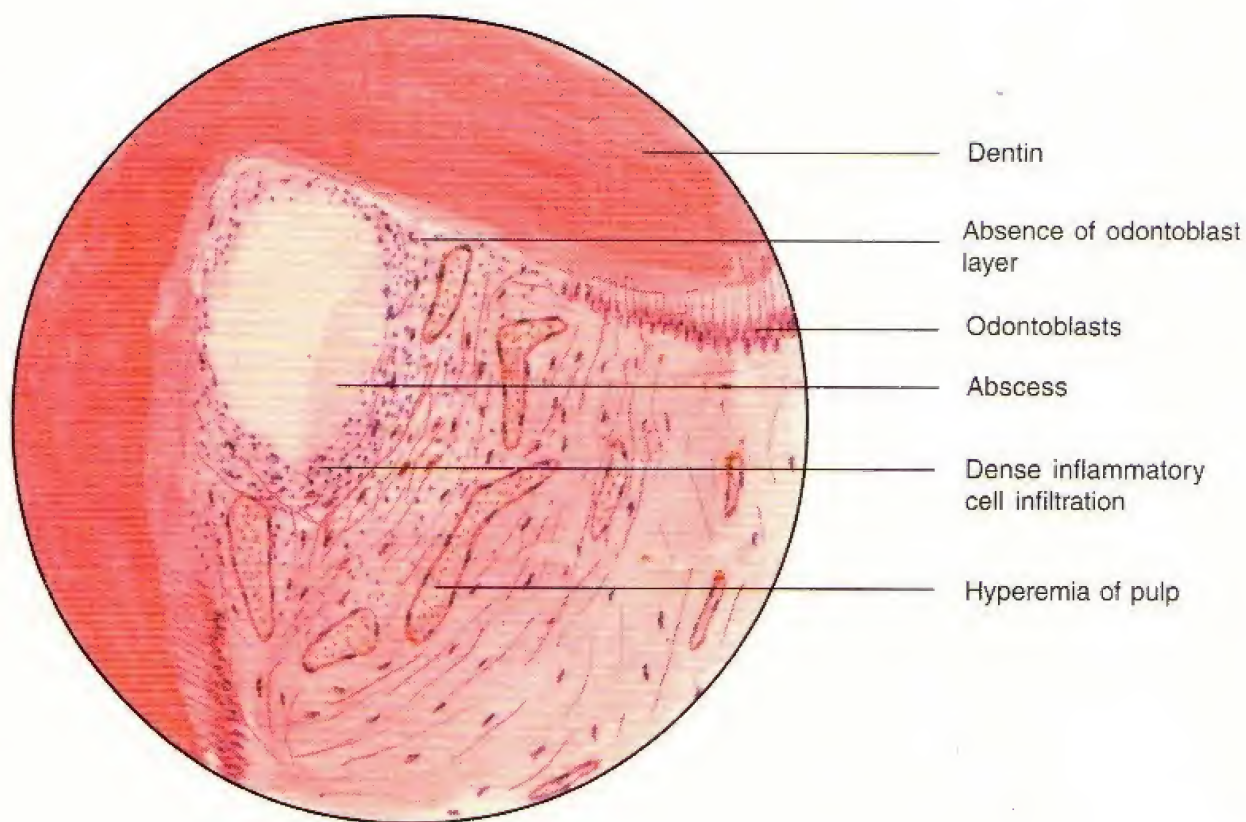


Fig. 15.2 Pulp abscess


Identification Points Fig. No.15.2
PULP ABSCESS

- Abscess is seen as small void
- Dense inflammatory cell infiltration around the abscess
- Hyperemic changes in the surrounding areas

tissue and formation of pulp abscess. Pulp abscess contain pus arising from break down of leukocytes, bacteria and tissue. Pulp abscess is seen as a small void surrounded by dense band of leukocytic infiltration. The odontoblasts near the region of the abscess undergo degeneration. Adjacent pulpal tissue may show hyperemic changes.

CHRONIC HYPERPLASTIC PULPITIS (PULP POLYP)

This is a specific type of pulpitis in which pulp respond with an exuberant proliferation, to an irritation or stimulus. Most commonly involved teeth are deciduous molars and first permanent molars. These teeth have excellent blood supply due to large apical foramen. This, along with high tissue resistance in young individuals lead to proliferation of pulp. Clinically pulp polyp presents as a pink soft tissue mass filling the large carious lesion.

Histopathology (15.3)

Microscopically pulp polyp present as granulation tissue covered by stratified squamous epithelium. Granulation tissue comprises of delicate connective tissue exhibiting proliferating endothelial cells, budding capillaries and chronic inflammatory cells. Continuity to the pulpal tissue is evident which also shows inflammatory cell infiltration.


Identification Points Fig. No.15.3
PULP POLYP

- Chronic proliferative reaction of pulp
- Granulation tissue covered by epithelium
- Connection to pulp is seen

PERIAPICAL GRANULOMA

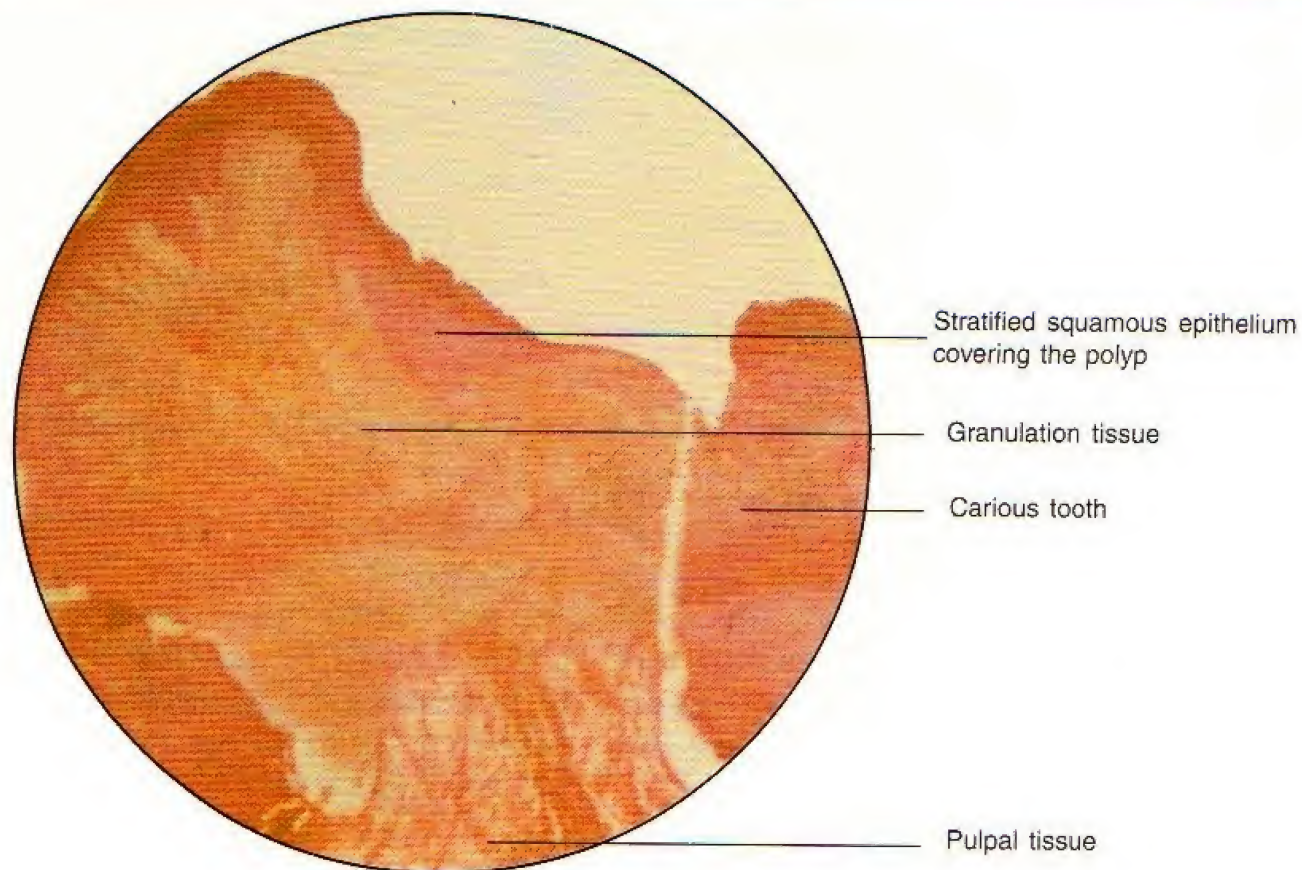
Periapical granuloma is a sequel to pulpitis that occur as a collection of granulation tissue at the root apex (peri apical – around the apex). The affected tooth is nonvital but relatively asymptomatic and this condition is identified in radiograph as a well defined radiolucency, often less than 2 cms size.

Histopathology (Fig. 15.4)

Histopathologically periapical granuloma comprises of granulation tissue attached to the root apex. Granulation tissue exhibits mixed inflammatory cell infiltrate consisting of lymphocytes, plasma cells, histiocytes and few polymorphonuclear leukocytes. Few giant cells, cholesterol clefts, Russel bodies (collection of gamma globulins produced by plasma cells) and few epithelial rest of Malassez are also seen in granulation tissue.


Identification Points Fig. No.15.4
PERIAPICAL GRANULOMA

- Granulation tissue attached to the root apex
- Mixed inflammatory cells, cholesterol clefts and Russel bodies may be seen
- Epithelial cell rests of Malassez may be present



Pulp polyp (Photomicrograph 4X)

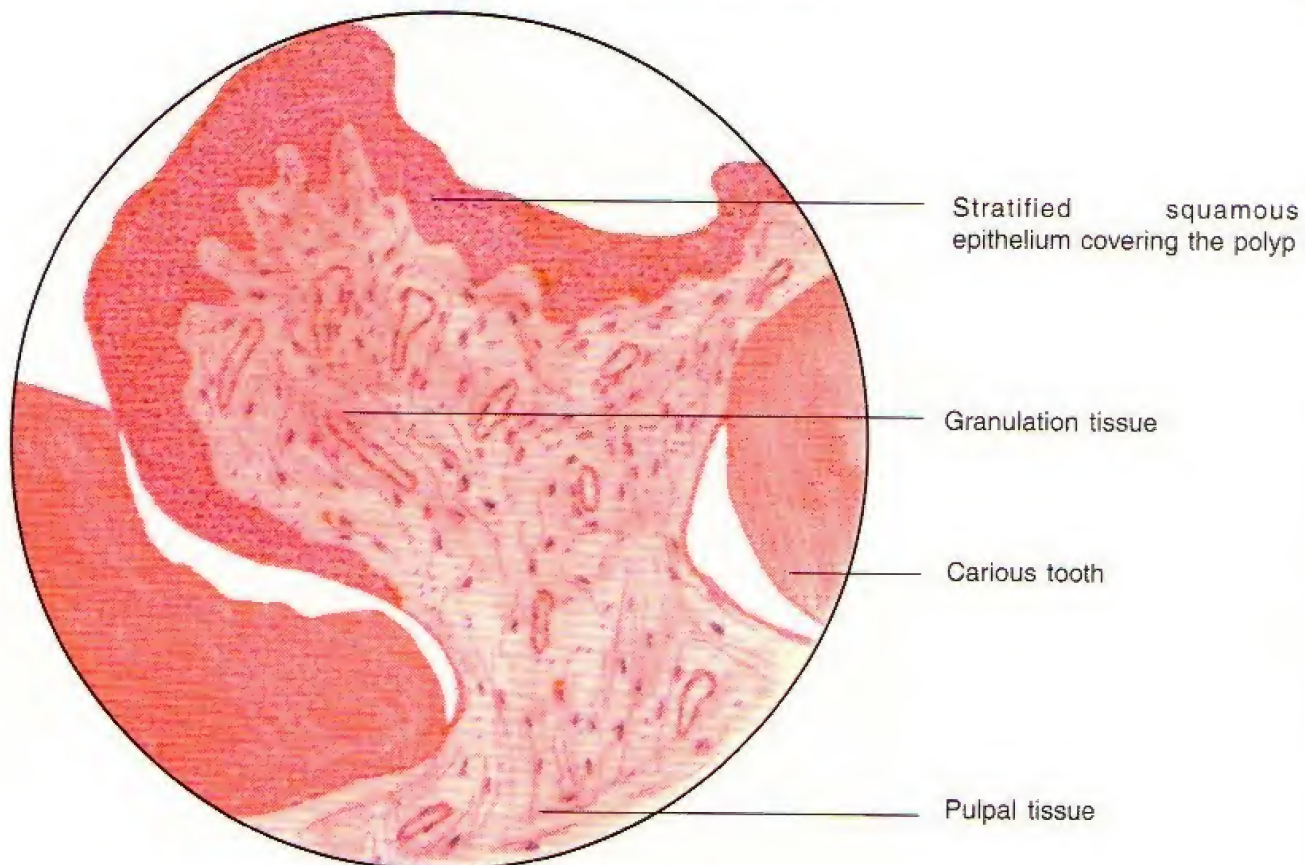
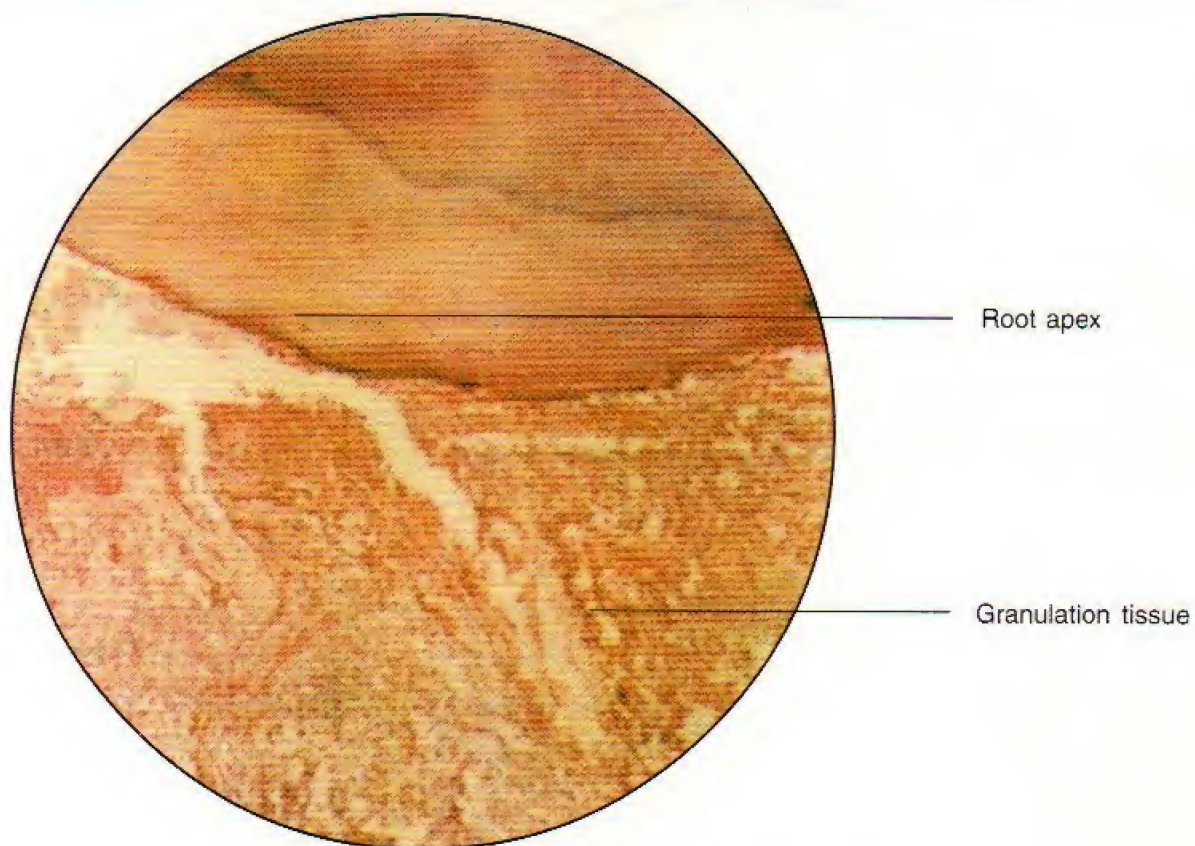


Fig. 15.3 Pulp polyp



Periapical granuloma (Photomicrograph 4X)

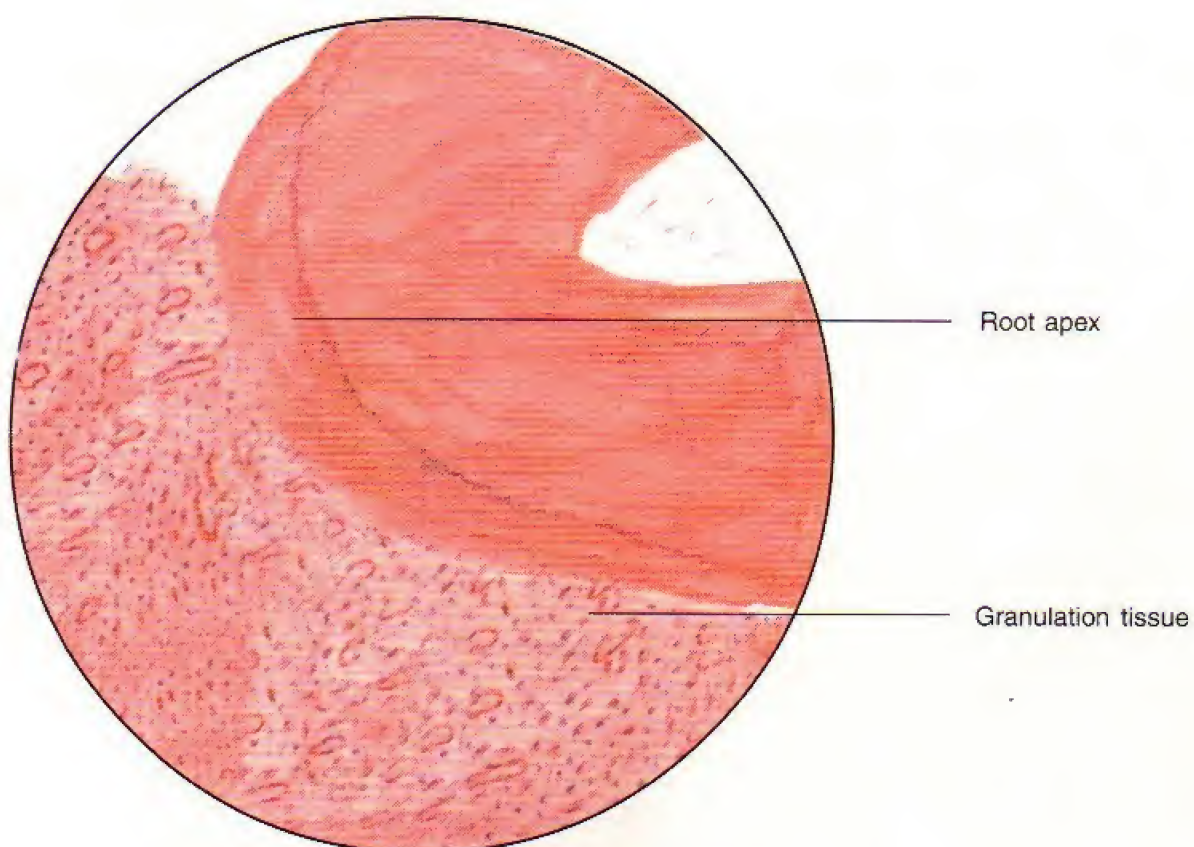


Fig. 15.4 Periapical granuloma

Bacterial and Fungal Infections

- Tuberculosis
- Actinomycosis
- Candidiasis

TUBERCULOSIS

Tuberculosis is a specific bacterial infection caused by *Mycobacterium tuberculosis*. Oral tuberculosis usually represents secondary infection from pulmonary lesions. Common oral manifestation is in the form of oral ulceration, mainly involving the tongue. Tuberculosis also manifest in the oral cavity as tubercular gingivitis, tubercular granuloma and osteomyelitis. Cervical lymph node involvement is referred to as scrofula.

Histopathology (Fig. 16.1)

Microscopic presentation of tuberculosis is in the form of granulomas, which are circumscribed lesions. These granulomas have a central area of caseous necrosis surrounded by multinucleated giant cells and epithelioid cells. The nuclei of multinucleated giant cells are seen at the periphery, having a horse shoe shaped

arrangement and these cells are called Langhans' giant cells. This is surrounded by a zone of lymphocytic infiltration and fibrosis. Tubercular organisms may be demonstrated by Ziehl – Neelsen or other acid fast stains.



Identification Points Fig. No.16.1

TUBERCULOSIS

- Granuloma with central caseation necrosis
- Presence of Langhans' giant cells and epithelioid cells
- Peripheral zone of lymphocytes

ACTINOMYCOSIS

Actinomycosis is a chronic granulomatous infection caused by actinomyces species of organisms. This disease manifest as cervicofacial, abdominal or pulmonary forms. Cervicofacial actinomycosis manifest as indurated swelling which eventually develop central abscess that drain through multiple sinuses. Actinomycosis may also manifest as osteomyelitis.

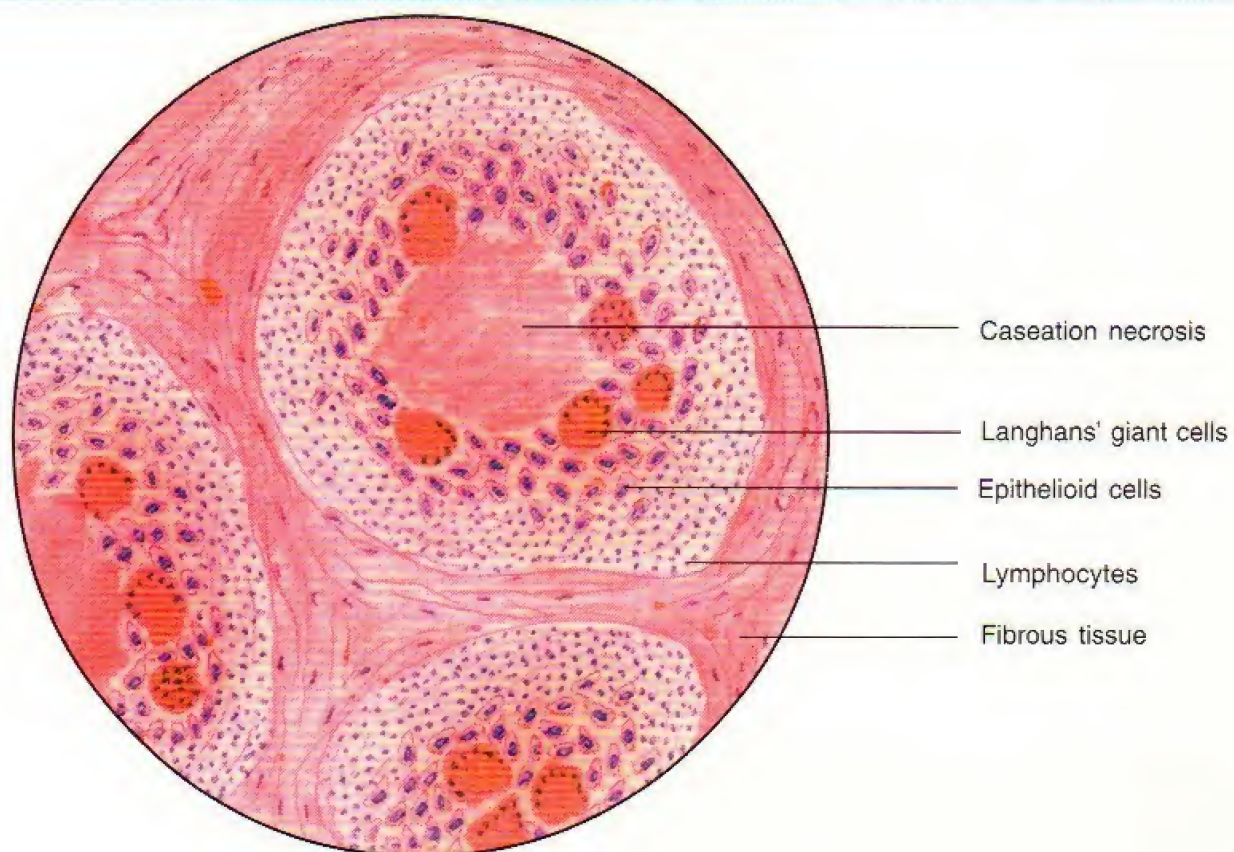


Fig. 16.1 Tubercular granuloma

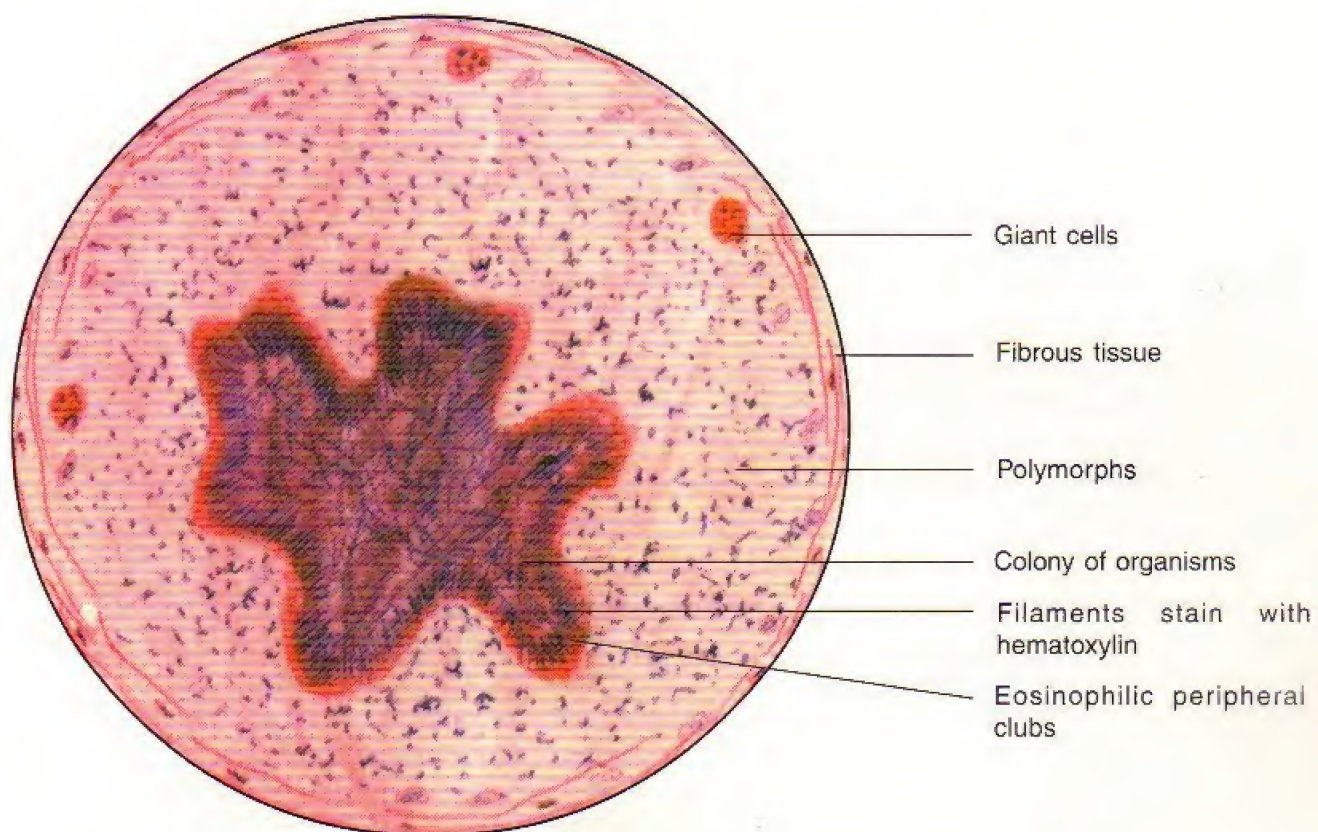


Fig. 16.2 Actinomycosis

Histopathology (Fig. 16.2)

Classic lesions of actinomycosis are granulomatous with central abscess formation. The central area may show characteristic colonies that appear to be floating in a collection of polymorphonuclear leukocytes. These colonies appear round or lobulated and made up of meshwork of filamentous organisms that stain hematoxylin and show eosinophilia of peripheral clubs. Since the colonies have peripheral radiating filaments forming a rosette pattern these are referred to as 'ray fungus'. Around the polymorphs there is a zone of histiocytes and multinucleated giant cells. A zone of fibrosis is seen at the periphery.

**Identification Points Fig. No. 16.2****ACTINOMYCOSIS**

- Colony of organisms described as 'ray fungus'
- Organisms surrounded by polymorphs
- Presence of few multinucleated giant cells and histiocytes

CANDIDIASIS

Candidiasis is the commonest fungal infection affecting oral cavity caused by *Candida albicans* and other related organisms. *Candida albicans* are the commensal organisms of the oral cavity. Invasion of the oral mucosa by these organisms

occur in certain conditions, producing candidiasis. Although there are various predisposing factors, the most important one is immunosuppression.

Oral candidiasis may manifest in different forms; - acute pseudomembranous (thrush), acute atrophic (antibiotic sore mouth), chronic atrophic (denture sore mouth) and chronic hyperplastic.

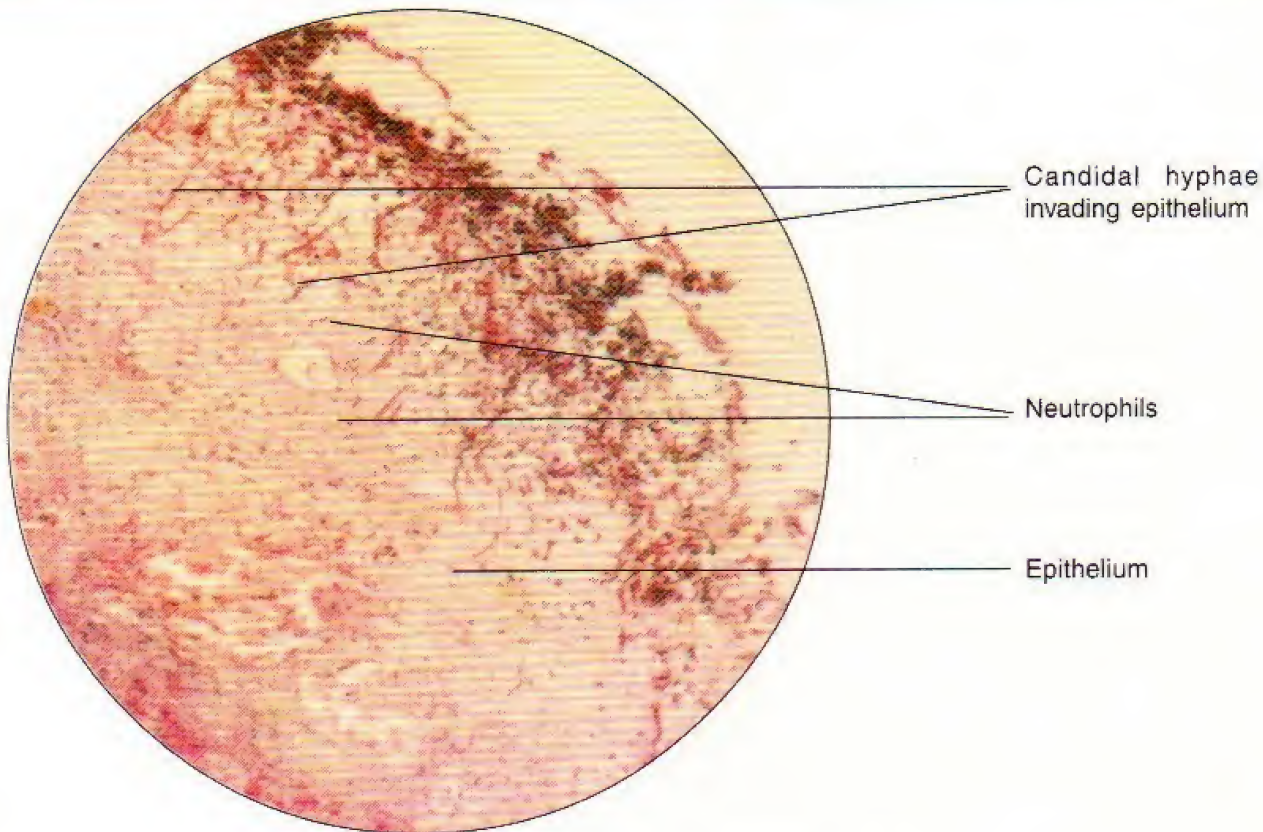
Histopathology (Fig. 16.3)

Candidal organisms can be demonstrated in a smear stained by PAS (periodic acid Schiff) stain. The organisms appear as magenta color hyphae or pseudohyphae. Hyphae vary in length and approximately of 2 microns in diameter.

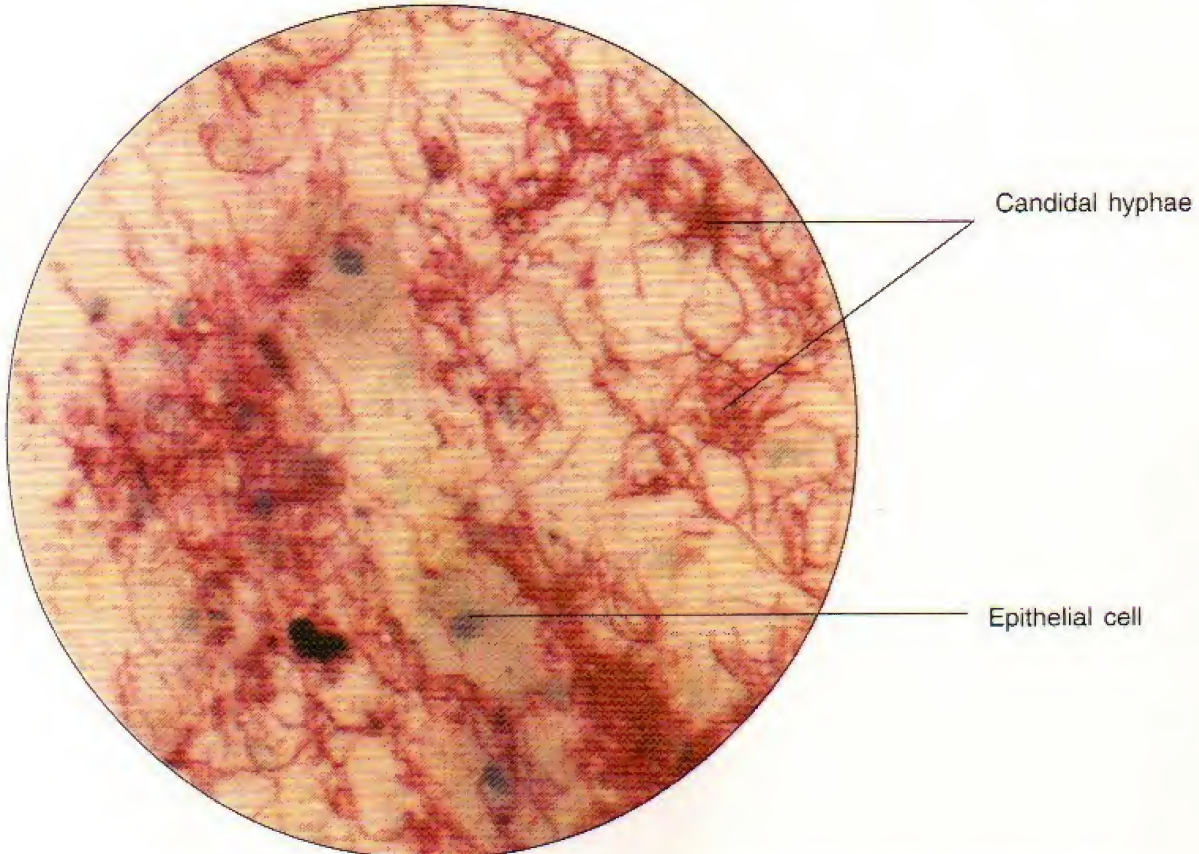
In a biopsy specimen, these hyphae are seen perpendicular to the epithelium invading the superficial layers. The epithelium shows hyperkeratosis with elongation of rete ridges and collection of neutrophils in the parakeratin layer and superficial spinous layer. Candidal organisms can be demonstrated by silver stains also.

**Identification Points Fig. No.16.3****CANDIDIASIS**

- PAS positive candidal hyphae invading the epithelium
- Epithelium may show hyperkeratosis and elongated rete ridges
- Collection of neutrophils in the epithelium



Candidiasis (PAS stain) (Photomicrograph 10X)



Candidal hyphae in PAS stained smear preparation (Photomicrograph 10X)

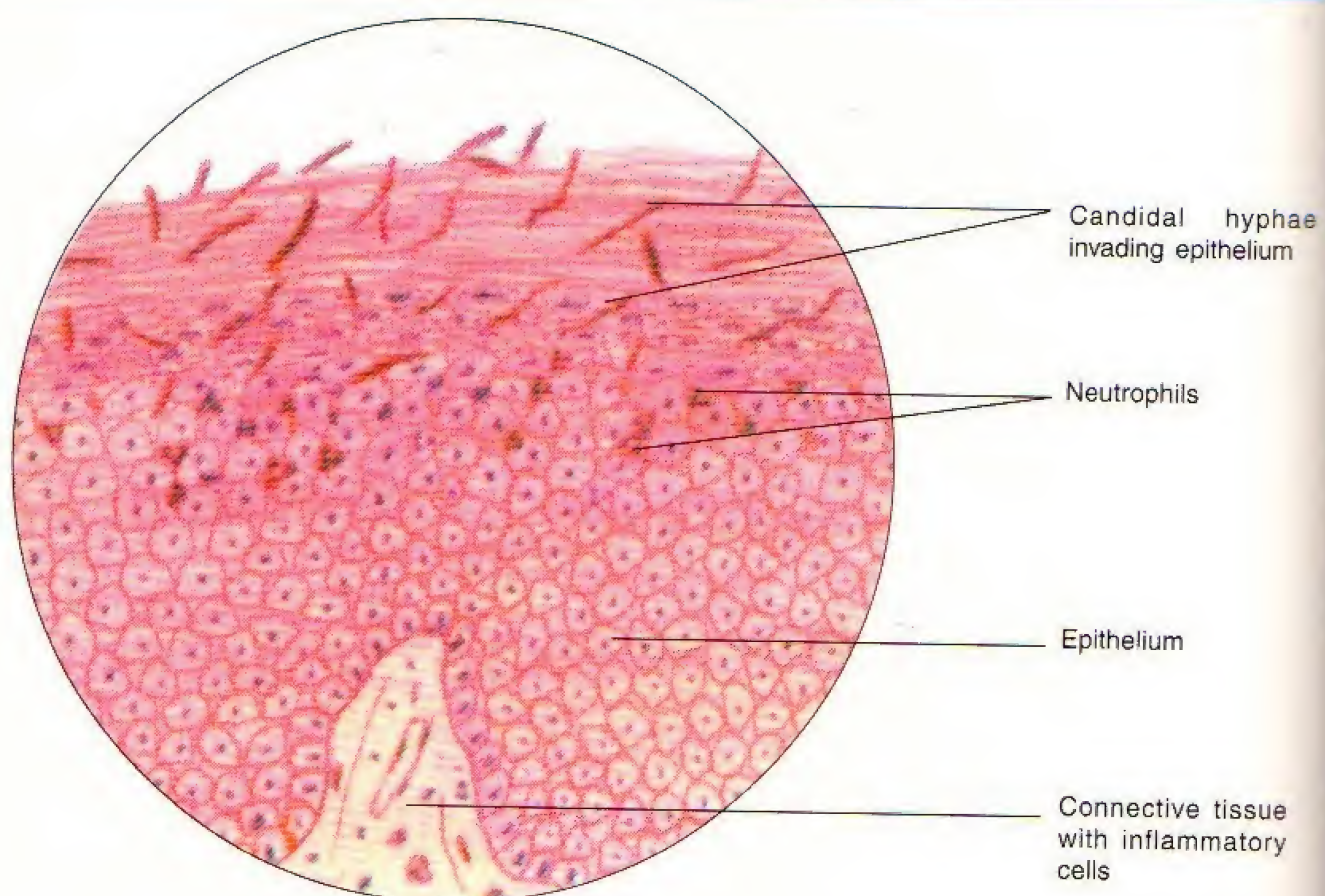


Fig. 16.3 Candidiasis (PAS stain)

17

Salivary Gland Neoplasms

- Pleomorphic adenoma
- Warthin's tumor
- Adenoid cystic carcinoma
- Mucoepidermoid carcinoma

Salivary gland tumors constitute major group of neoplasms of oral cavity. These may be broadly classified in to benign or malignant neoplasms based on the biological behavior.

PLEOMORPHIC ADENOMA

Pleomorphic adenoma is the commonest benign salivary gland neoplasm mainly affecting parotid gland. It is also called mixed tumor of salivary gland because of presence of different types of tissues observed in a microscopic section. Clinically this lesion presents as slow growing painless firm mass without fixation to the surrounding structures.

Histopathology (Fig. 17.1)

Pleomorphic adenoma is a well circumscribed tumor with complete or partial encapsulation

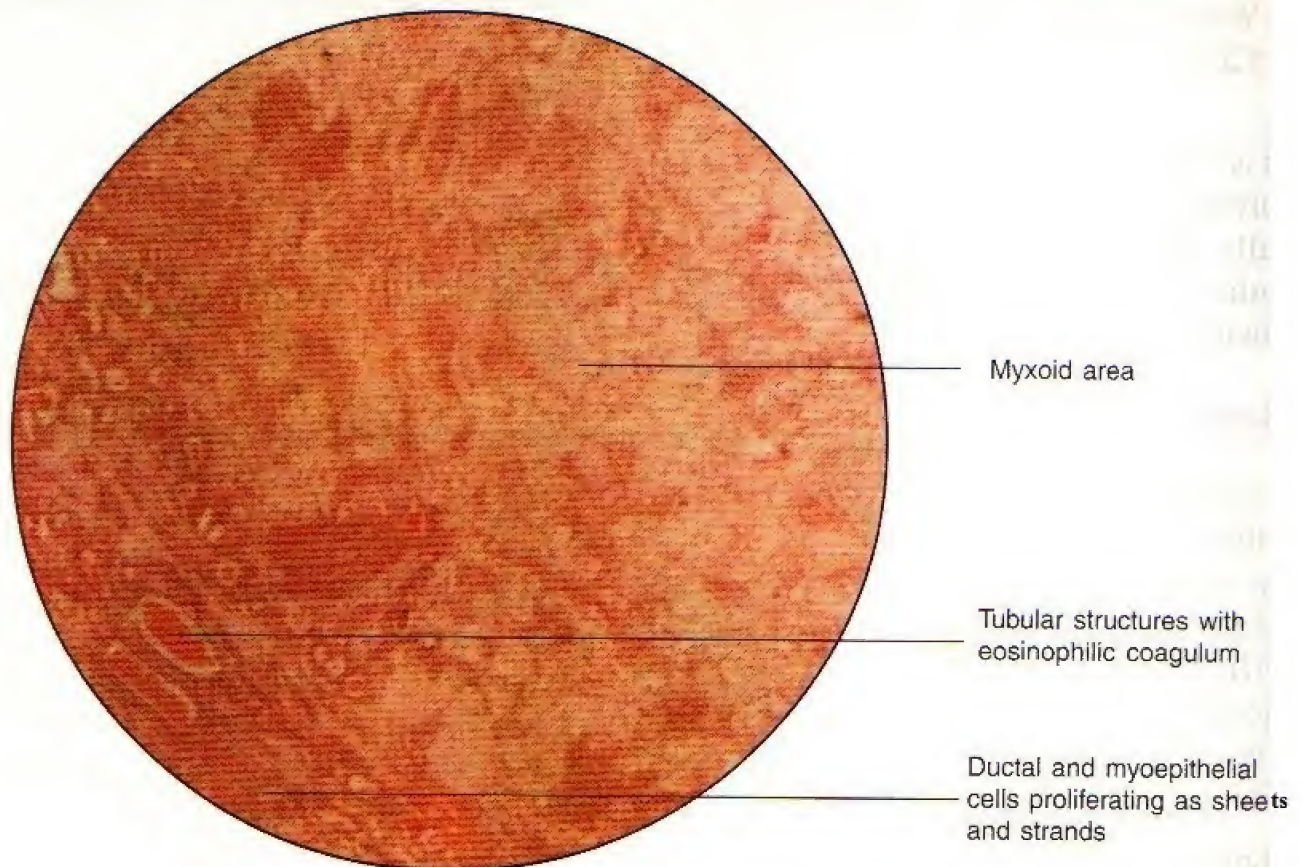
with dense fibrous tissue. Tumor has epithelial and mesenchymal components. Epithelial components include proliferating ductal and myoepithelial cells, forming ductal structures containing eosinophilic material. These cells also may form sheets, strands or islands. Ductal cells are cuboidal in shape with scanty cytoplasm. Myoepithelial cells have varying morphology, angular, spindle shaped or plasmacytoid appearance. Metaplastic changes of epithelial component may lead to formation of squamous cells, sometimes even with keratin pearl formation. This lesion also shows mesenchymal components in the form of loose myxoid tissue or mucoid, chondroid or osseous areas and foci of hyalinized connective tissue.



Identification Points Fig. No. 17.1

PLEOMORPHIC ADENOMA

- Mixture of different types of tissues.
- Cells arranged in cords, sheets or duct like pattern containing eosinophilic material.
- Myxoid, chondroid, osseous, mucoid or hyalinized areas of connective tissue.



Pleomorphic adenoma (Photomicrograph 10X)

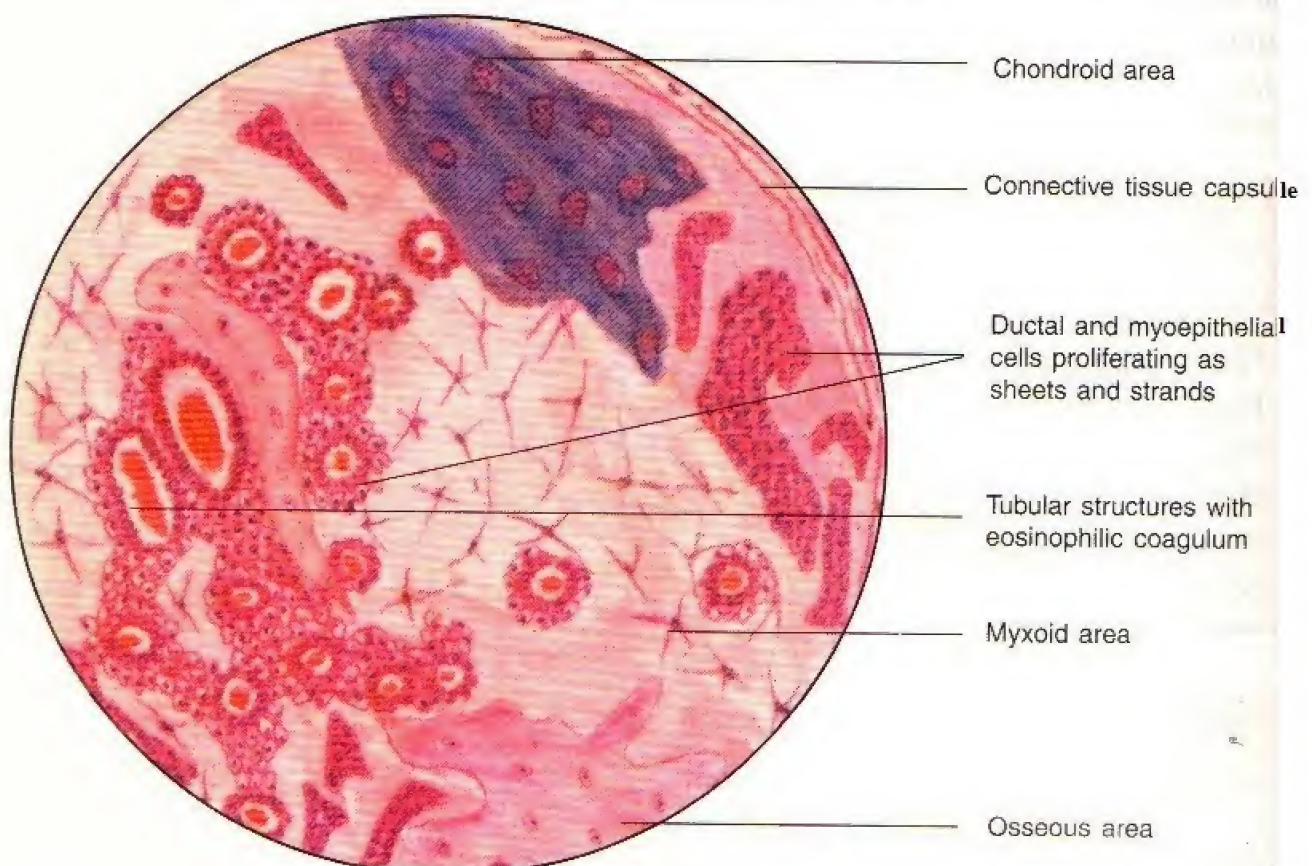


Fig. 17.1 Pleomorphic adenoma

WARTHIN'S TUMOR (PAPILLARY CYSTADENOMA LYMPHOMATOSUM)

This is a benign tumor of salivary gland, mainly involving the parotid gland. Warthin's tumor usually present as a slow growing, painless, nodular mass of the parotid gland, firm or fluctuant, affecting elderly individuals.

Histopathology (Fig. 17.2)

Microscopically two components are seen in Warthin's tumor, epithelial and lymphoid. As the name papillary cystadenoma lymphomatosum indicates, this lesion is basically cystic, with papillary processes lined by epithelium, projecting in to the cystic space. Connective tissue has abundant lymphoid component exhibiting germinal center.

Epithelium lining the papillary projections is bilayered with inner cuboidal cells and outer columnar cells. Columnar cells are regularly arranged having palisading arrangement of nuclei. Cystic space may contain eosinophilic material.



Identification Points Fig. No.17.2

WARTHIN'S TUMOR

- Papillary projections into cystic spaces
- Bilayered epithelium lining the projections with inner cuboidal and outer columnar cells.
- Lymphoid component exhibiting germinal centers.

ADENOID CYSTIC CARCINOMA (CYLINDROMA)

Adenoid cystic carcinoma is a malignant salivary gland tumor. Clinically this tumor present with

slow growing swelling which may show typical features of malignancy like, local pain fixation to surrounding structures, surface ulceration, facial nerve paralysis etc.

Histopathology (Fig. 17.3)

The tumor is composed of uniform cells, resembling basal cells arranged in anastomosing cords or duct like pattern. Some of these duct like areas contain a mucoid material. The above mentioned feature gives rise to the characteristic appearance described as cribriform, 'honey comb' or 'Swiss cheese' pattern. There may be areas where the cells show a tubular or more solid pattern. The connective tissue component is often hyalinized, and surrounding the tumor cells, forming a structural pattern of cylinders. The term cylindroma is given because of this cylindrical pattern.



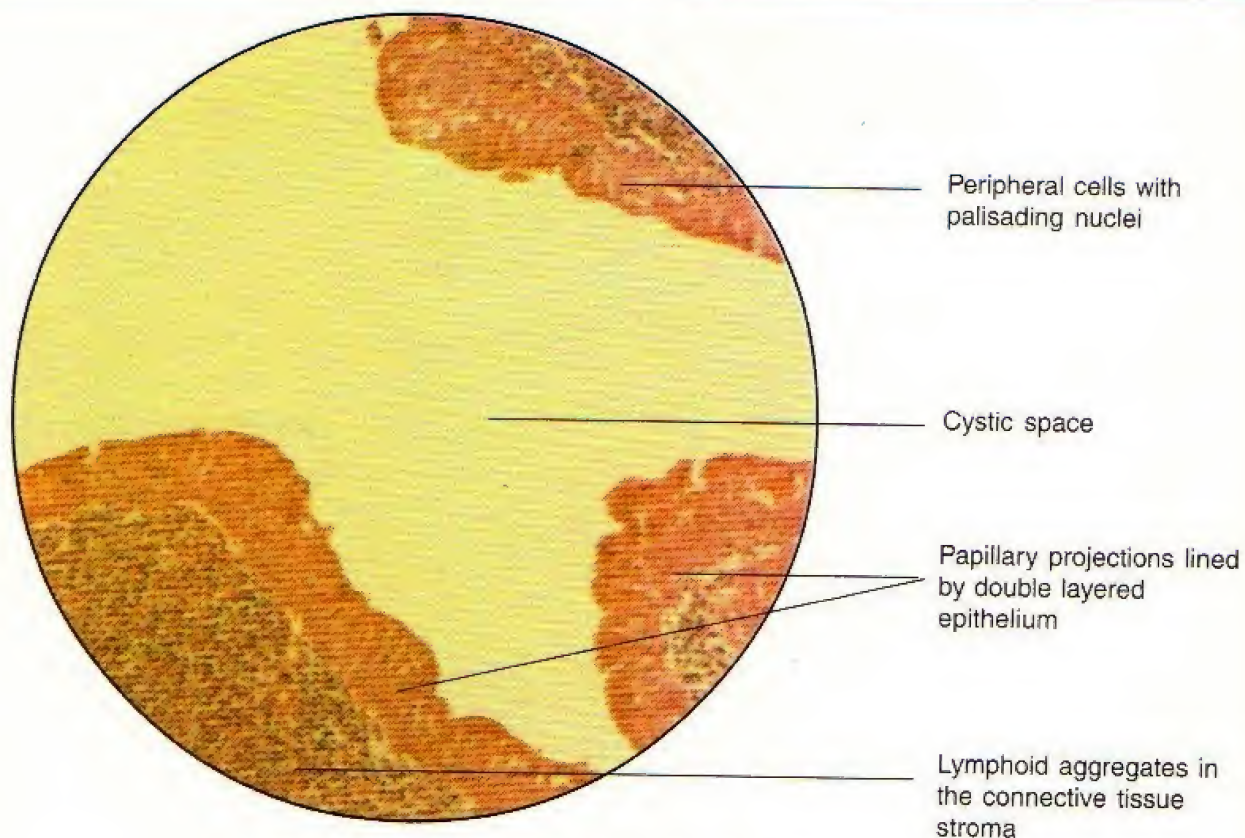
Identification Points Fig. No.17.3

ADENOID CYSTIC CARCINOMA

- 'Cribriform' or 'Swiss cheese' pattern
- Uniform tumor cells resembling basal cells
- Hyalinized connective tissue.

MUCOEPIDERMOID CARCINOMA

Mucoepidermoid carcinoma is a malignant salivary gland neoplasm arising from epithelium of large ducts of salivary glands. Although parotid is commonly affected, minor salivary glands also may be involved. Clinical features can vary depending on grades of malignancy. Low grade lesions are slow growing and painless. High grade lesions on the other hand show rapid growth, fixation to adjacent structures, facial nerve paralysis and pain as an early symptom.



Warthin's tumor (Photomicrograph 10X)

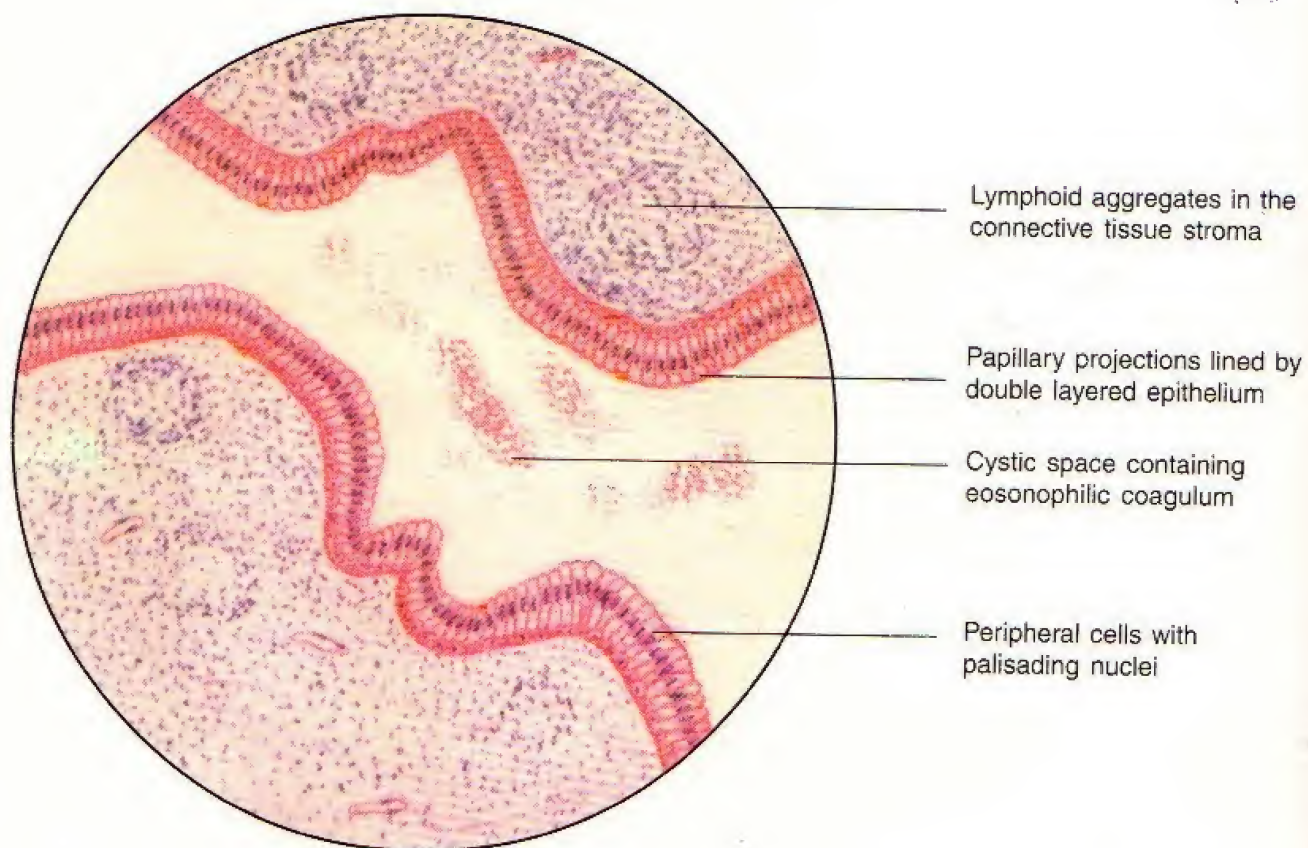
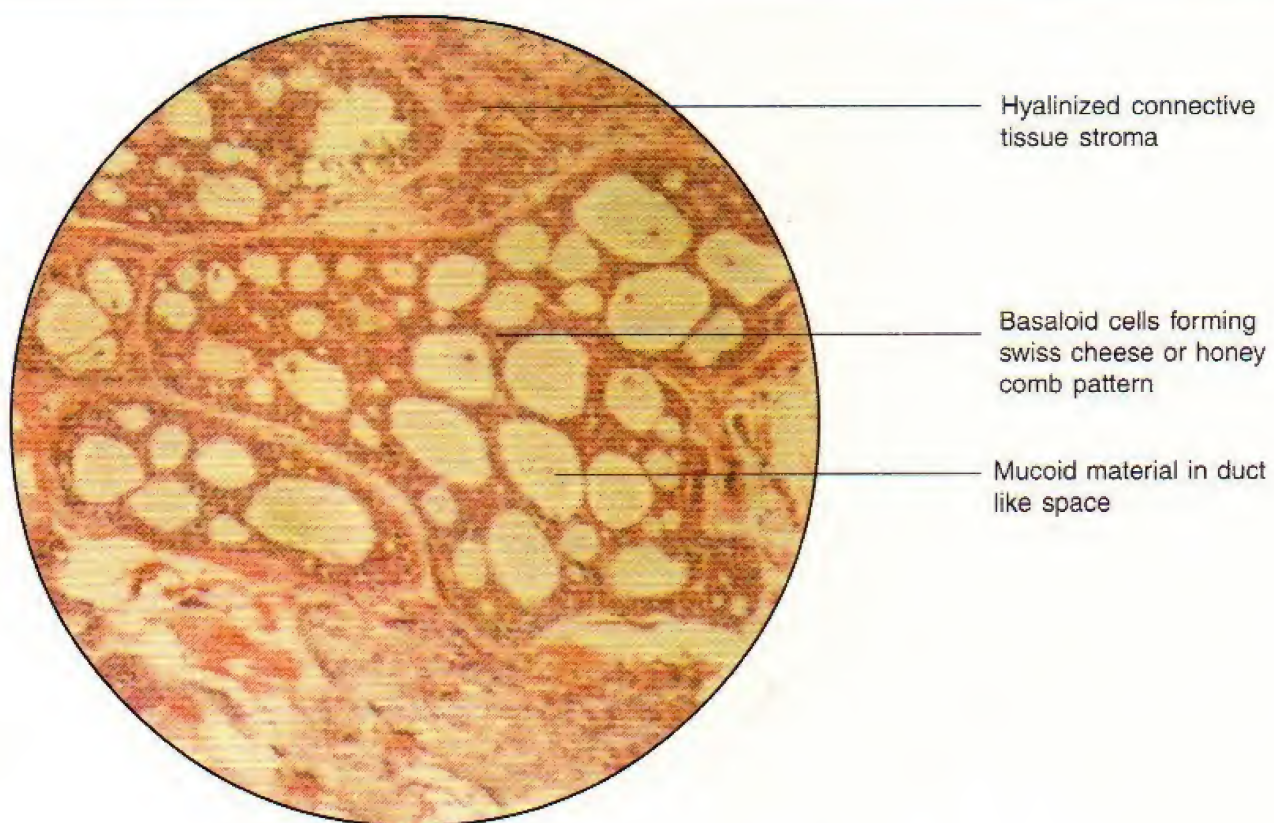


Fig. 17.2 Warthin's tumor



Adenoid cystic carcinoma (Photomicrograph 10X)

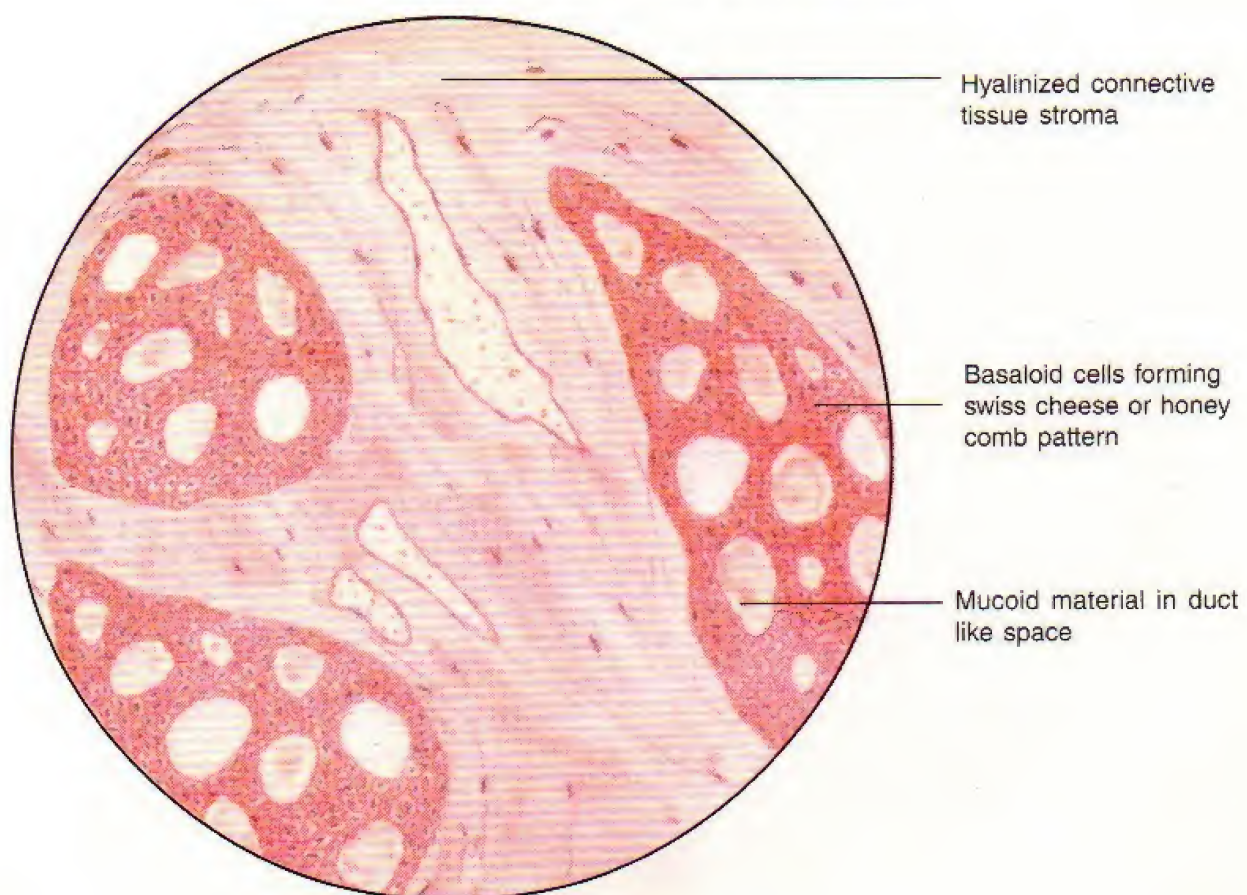
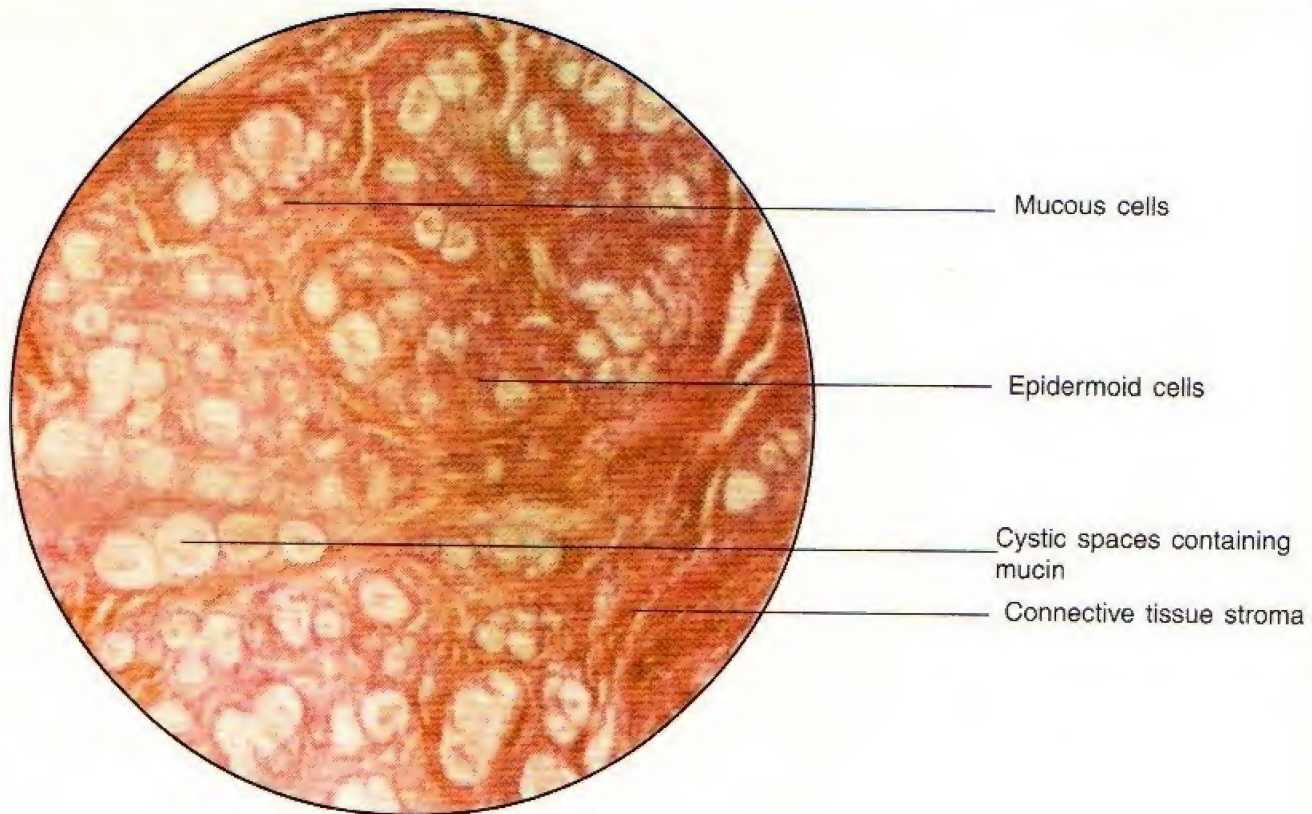


Fig. 17.3 Adenoid cystic carcinoma



Muco epidermoid carcinoma (Photomicrograph 4X)

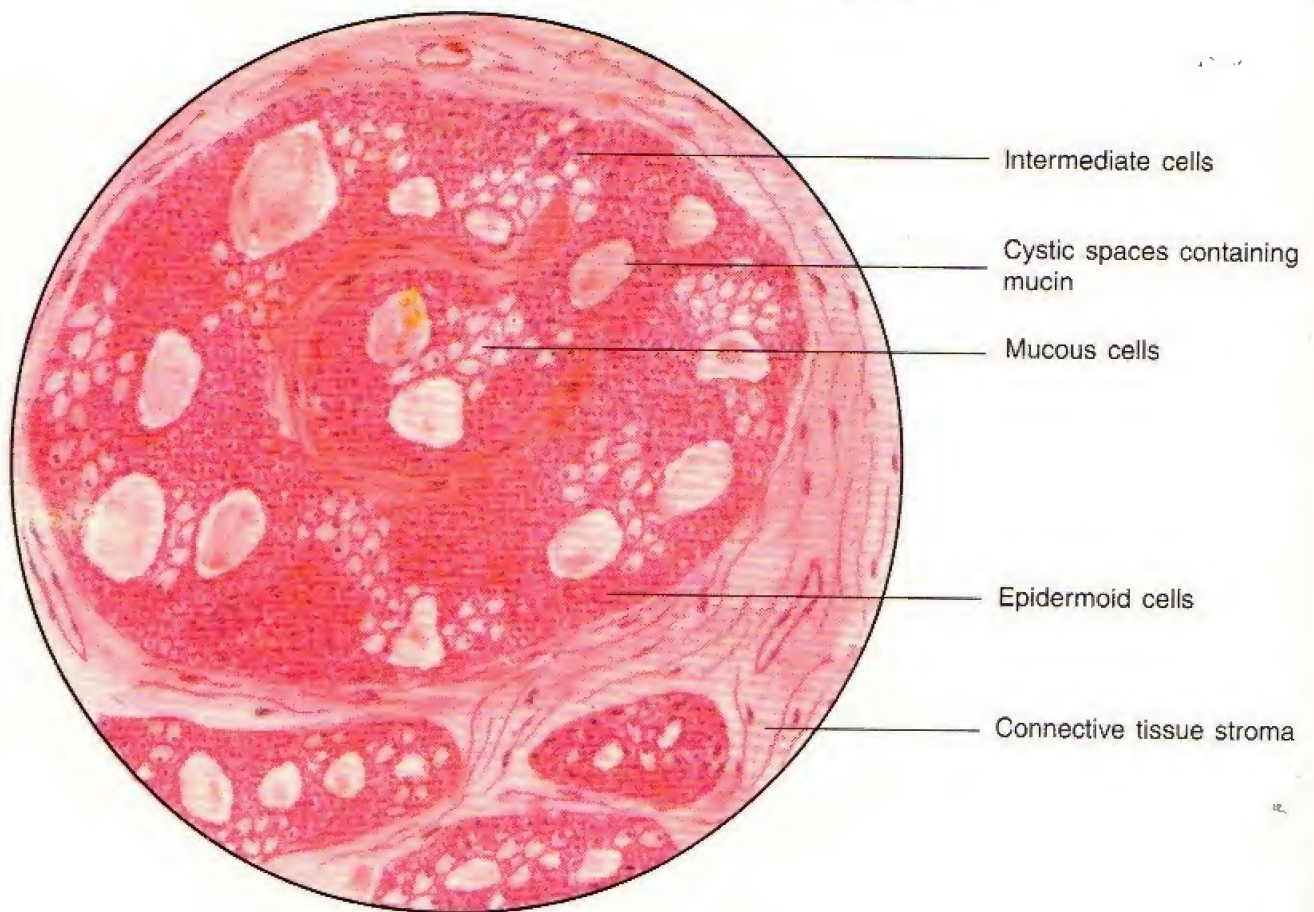


Fig. 17.4 Muco epidermoid carcinoma

Histopathology (Fig. 17.4)

Microscopically 3 types of cells are seen, dispersed in connective tissue stroma. One type is the epidermoid cells which are squamous with distinct intercellular bridges, rarely with evidence of keratin formation. Another type is mucous secreting cells which are ovoid, filled with mucin and peripherally placed nucleus. These cells appear as clear cells in H & E stained sections and positively stain with PAS and mucicarmine stain. Intermediate cells are another type of cells, ovoid with small darkly staining nucleus and scanty eosinophilic cytoplasm.

Based on histopathological findings mucoepidermoid carcinoma is graded as low, intermediate or high grade malignancy.

Low grade malignancy shows predominantly mucous cells with many microcystic spaces containing mucin. Epidermoid and intermediate cells are less in number. In high grade

**Identification Points Fig. No.17.4****MUCOEPIDERMOID CARCINOMA**

- Three types of cells, mucous secreting cells, epidermoid cells, intermediate cells
- Cystic spaces containing PAS positive mucin material
- Histologically lesions can be graded into low, intermediate or high grade.

malignancy, epidermoid cells predominate with less number of mucous secreting and intermediate cells. Cells are arranged in clusters with more solid and less cystic areas. Neoplastic cells show atypical changes. Intermediate grade lesions show intermediate histological features between low and high grade showing both epidermoid and mucous cells. Intermediate cells seldom predominate.

- Lichen planus
- Pemphigus
- Pemphigoid

LICHEN PLANUS

Lichen planus is a chronic mucocutaneous disorder manifested in various forms in the oral cavity. The most characteristic pattern is reticular type with interlacing white striae called as Wickham's striae

Histopathology (Fig. 18.1)

Microscopically lichen planus shows changes in all layers of epithelium and connective tissue. The epithelium is hyper ortho or parakeratotic, with



Identification Points Fig. No. 18.1

LICHEN PLANUS

- Hyper ortho or parakeratosis
- Basal cell degeneration
- Saw tooth rete ridges
- Sub epithelial band of lymphocytic infiltration

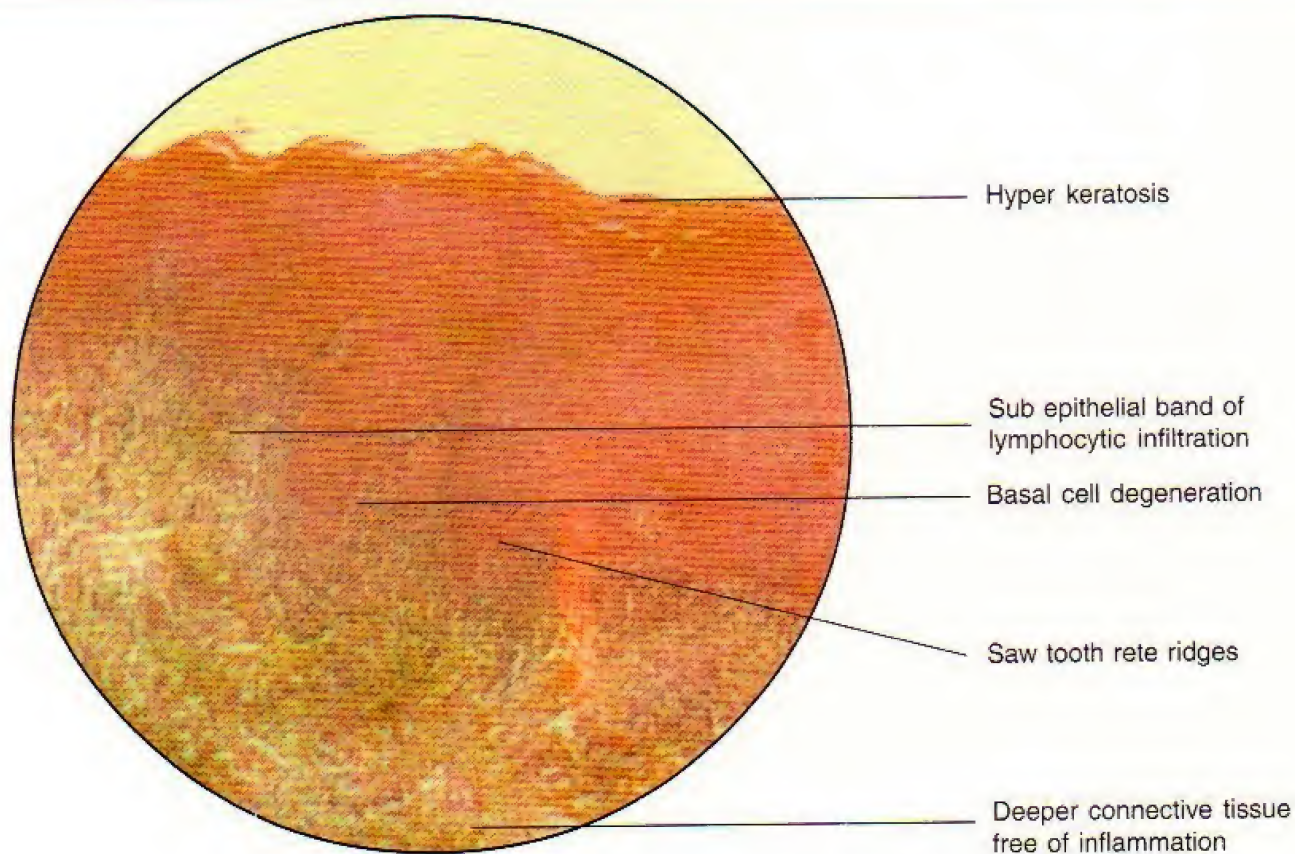
prominent stratum granulosum. Spinous layer shows acanthosis or atrophy. One of the characteristic feature is liquefaction degeneration of basal cells and eosinophilic material is seen replacing the basal cell layer. Rete ridges may be showing a 'Saw tooth' appearance. Another significant finding in lichen planus is subepithelial band of lymphocytic infiltration. Deeper part of the connective tissue is free from inflammation. Civatte bodies (eosinophilic apoptotic bodies) may be present in subepithelial connective tissue and in deeper spinous layer of epithelium.

PEMPHIGUS

Pemphigus is a tissue specific autoimmune disease affecting the skin and mucosa. Clinical manifestation is in the form of vesiculobullous lesions that rupture to form ulcers and erosions. Vesiculobullous lesions develop due to immune mediated acantholysis causing intraepithelial vesicle formation.

Histopathology (Fig. 18.2)

Characteristic microscopic picture of pemphigus is intra epithelial vesicle formation that occur in the supra basal layer. Basal layer is intact and is attached to the connective tissue. Spinous cell



Lichen planus (Photomicrograph 10X)

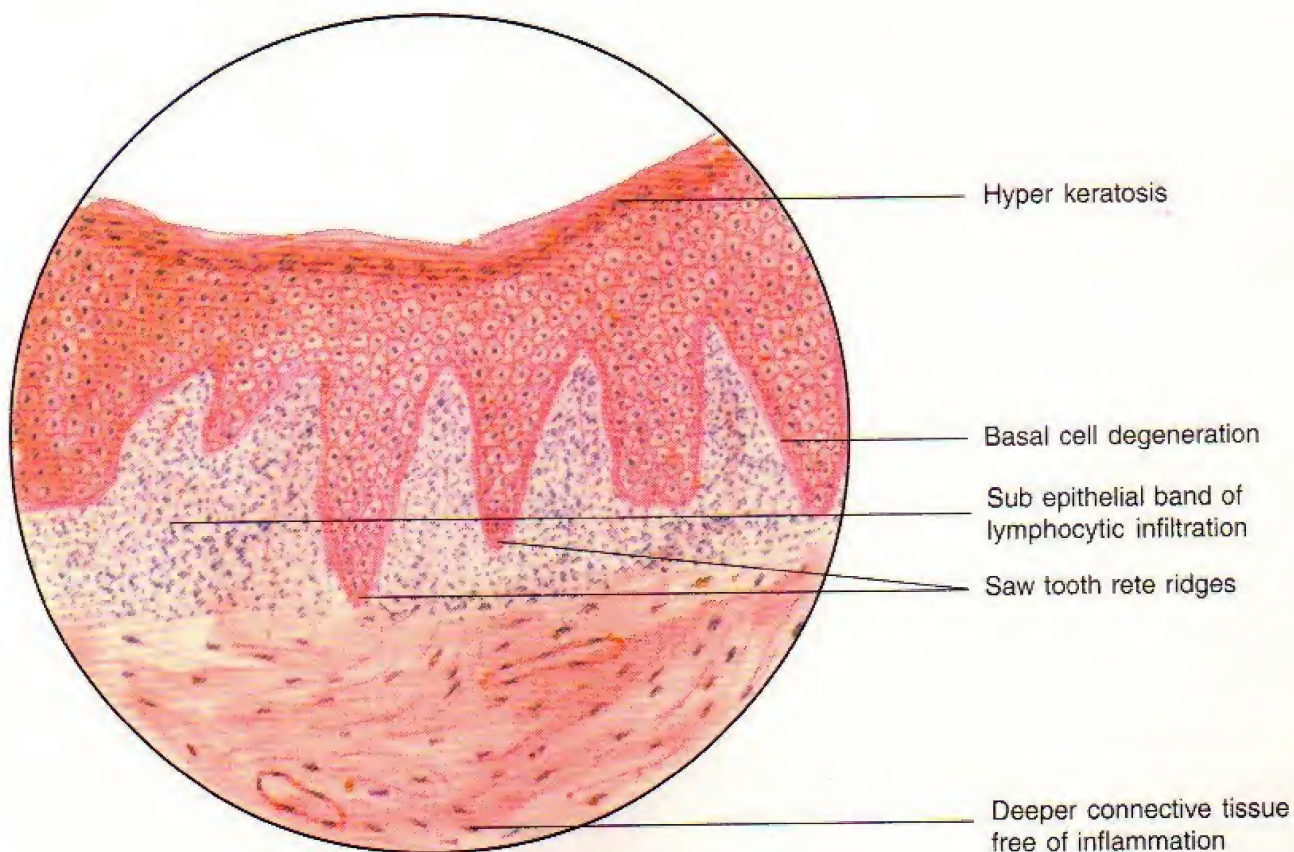


Fig. 18.1 Lichen planus

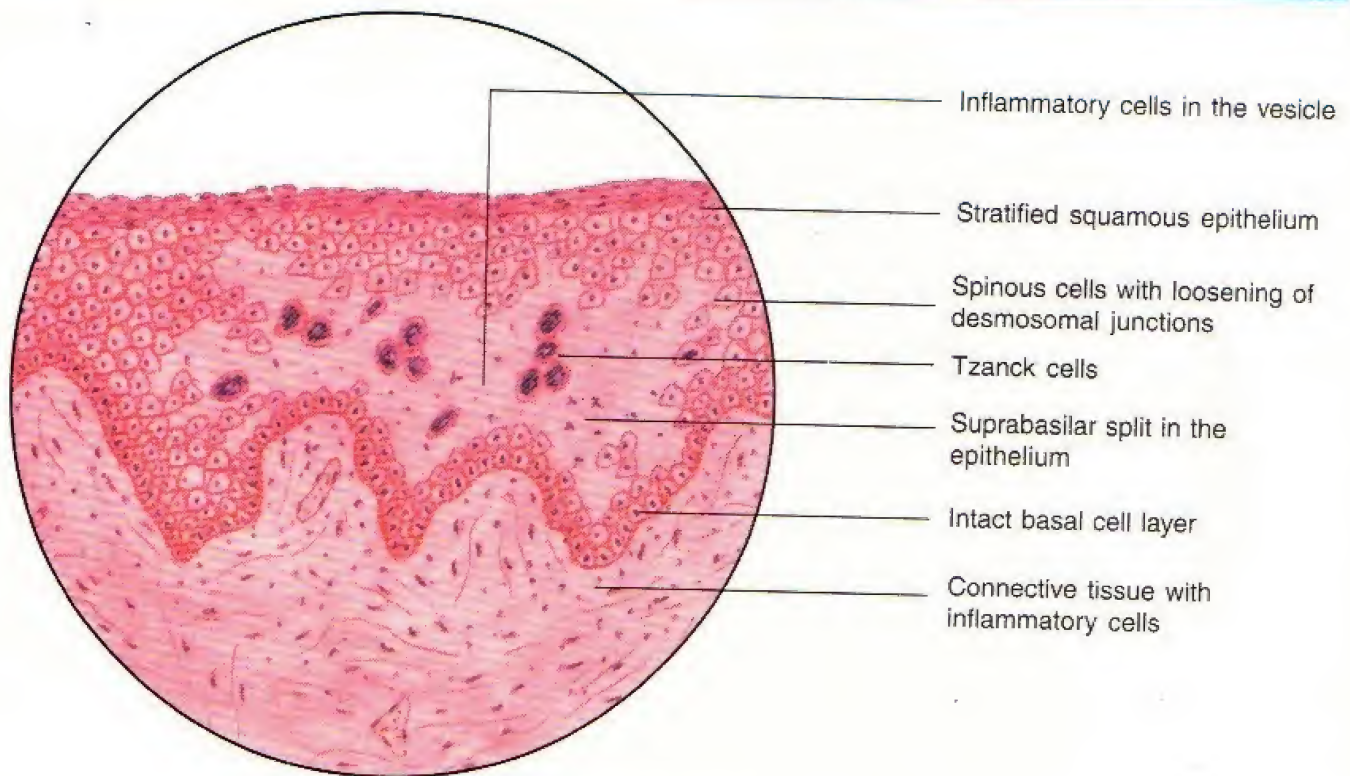


Fig. 18.2 Pemphigus

**Identification Points Fig. No. 18.2****PEMPHIGUS**

- Supra basal vesicle formation
- Intact basal layer
- Presence of Tzanck cells in the vesicle
- Inflammatory cells in the vesicle & connective tissue

layer shows acantholysis or destruction of intercellular junctions resulting in separation of cells. Loose cells are found in the vesicle which appear as round cells with degenerative changes like enlarged nuclei and hyper chromatic staining. These cells are called acantholytic cells or 'Tzanck cells'. Inflammatory cells are seen within the vesicle and in the sub epithelial connective tissue.

PEMPHIGOID

Pemphigoid is a vesiculobullous lesion that develop due to an autoimmune reaction directed

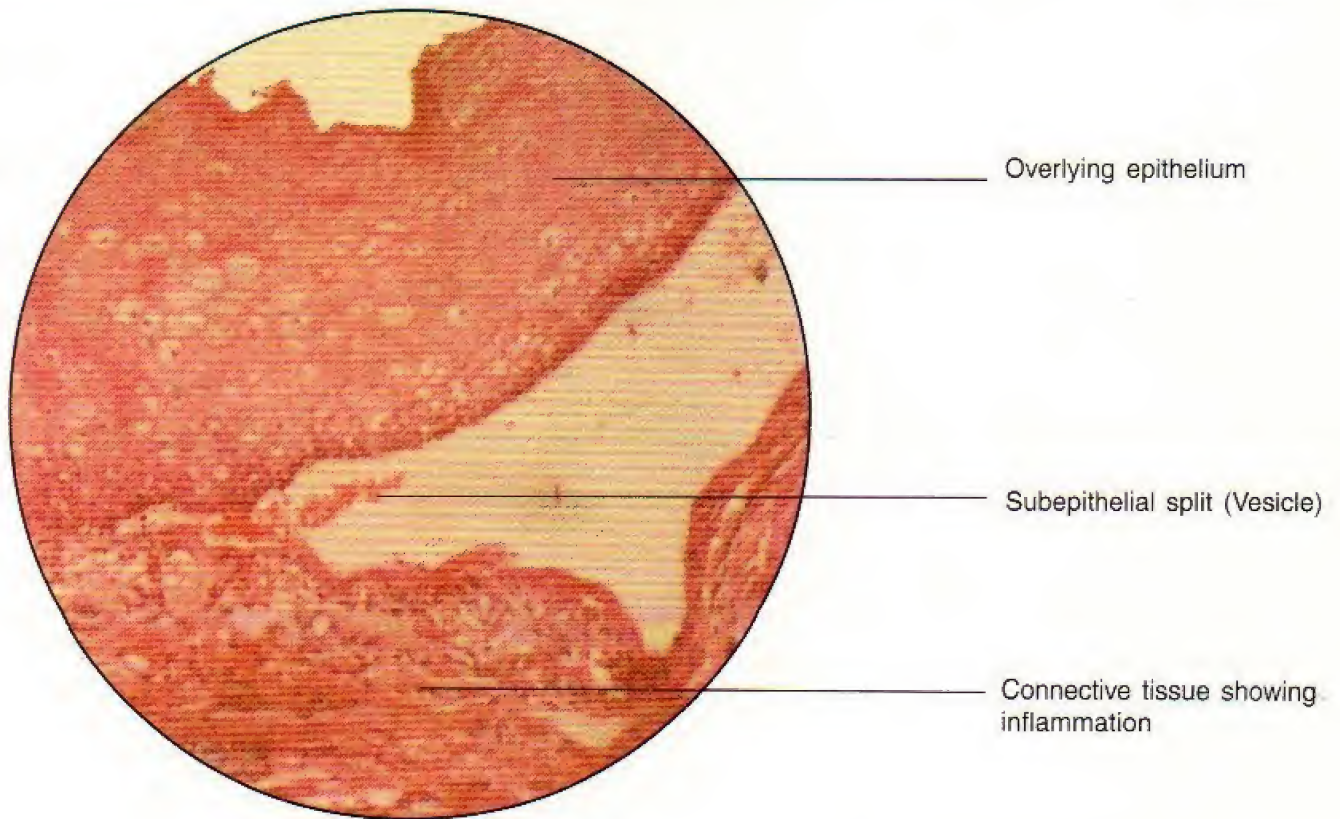
against some components of basement membrane. This results in separation of epithelium from the connective tissue with sub epithelial vesicle formation. Bullous pemphigoid and cicatricial pemphigoid are two different types of pemphigoid lesions.

HISTOPATHOLOGY (Fig. 18.3)

Characteristic feature of pemphigoid is sub epithelial vesicle formation. A split or a separation of epithelium from connective tissue is seen at the basement membrane zone. Epithelium is intact without any evidence of acantholysis. Connective tissue shows inflammatory cell infiltration.

**Identification Points Fig. No. 18.3****PEMPHIGOID**

- Sub epithelial vesicle formation
- Intact epithelium without acantholysis
- Inflammatory cells in the connective tissue



Pemphigoid (Photomicrograph 10X)

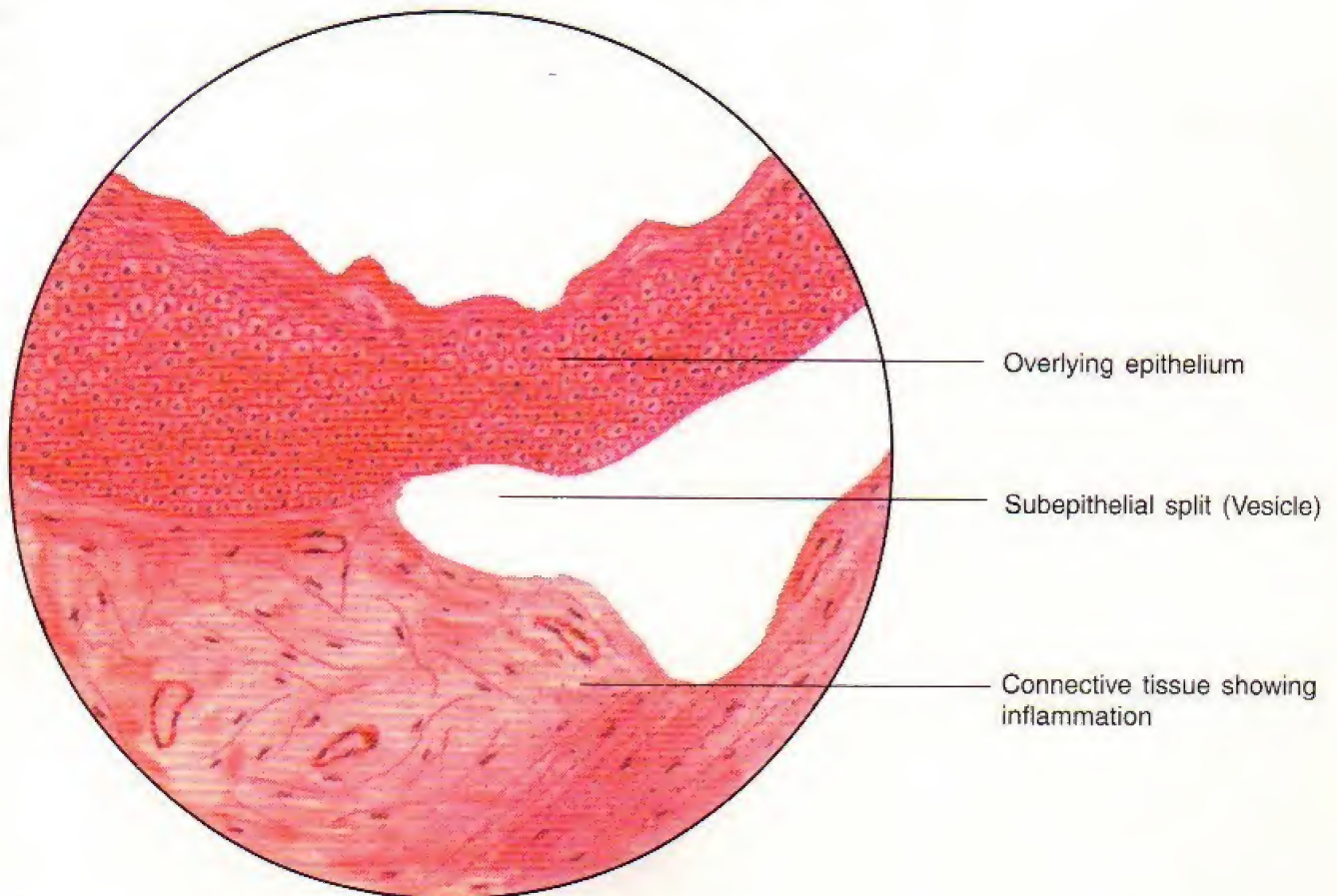


Fig. 18.3 Pemphigoid

- Fibrous dysplasia
- Paget's disease

FIBROUS DYSPLASIA

Fibrous Dysplasia is a fibro-osseous lesion characterized by replacement of bone by fibrous tissue in which metaplastic bone formation takes place.

Fibrous dysplasia may involve single bone (monostotic) or multiple bone (polyostotic). Maxilla is affected more frequently than mandible and clinically present as painless swelling of the affected bone causing facial asymmetry. Characteristic radiographic feature is the 'ground glass' appearance of affected bone.

Histopathology (Fig. 19.1)

The lesional tissue of fibrous dysplasia shows cellular, loosely arranged fibrous connective tissue stroma. Irregular trabeculae of woven bone, which may be 'C' shaped or 'Chinese character' shaped (Chinese letter pattern) are distributed in the stroma. Bony trabeculae lack



Identification Points Fig. No. 19.1

FIBROUS DYSPLASIA

- Cellular loose fibrous connective tissue stroma
- Irregular trabeculae of woven bone having 'Chinese letter pattern'
- Absence of osteoblastic rimming of bony trabeculae

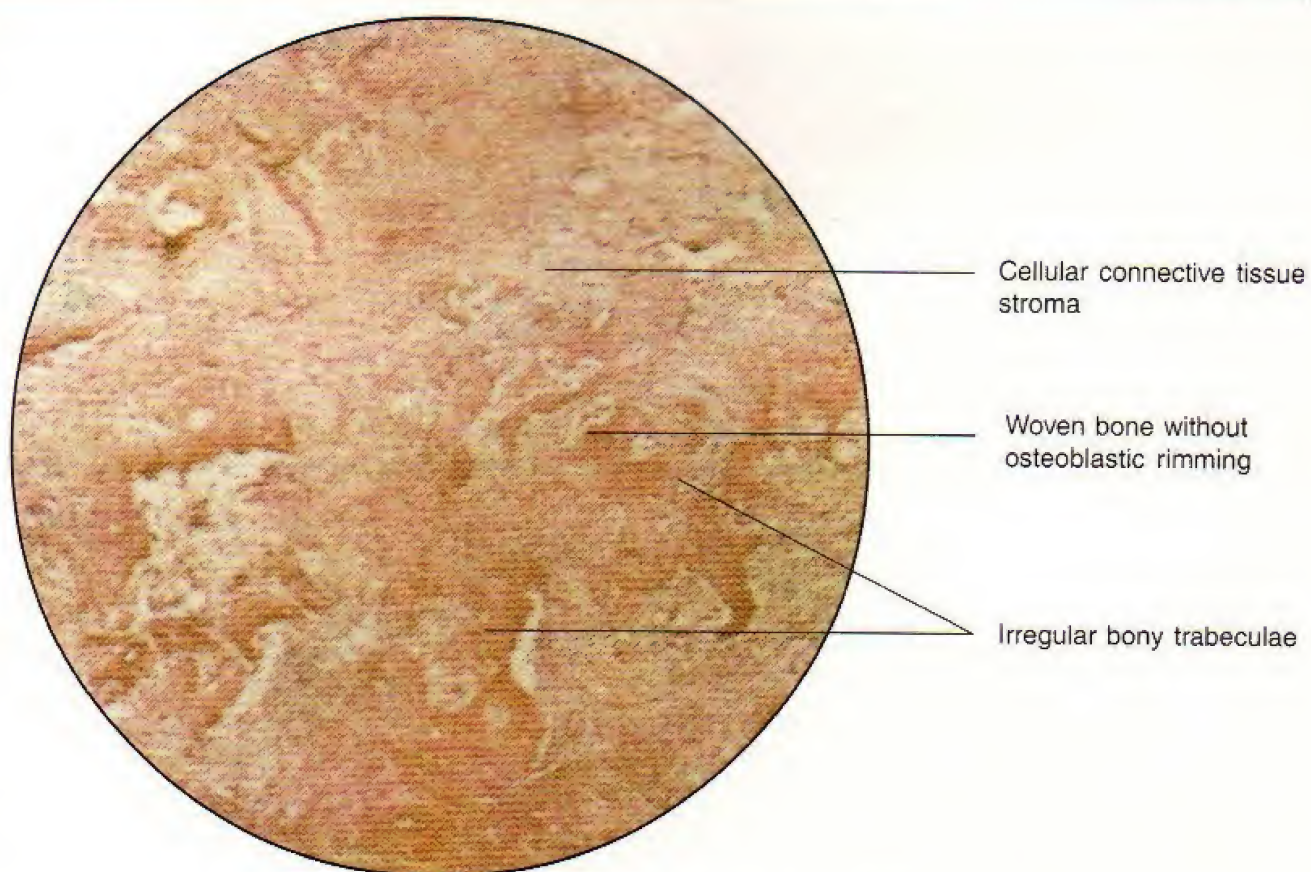
osteoblastic rimming. Lesional tissue merges with adjacent normal bone.

PAGET'S DISEASE

Paget's disease is a bone disorder that occurs due to abnormal bone remodeling resulting in deformed functionally inefficient bone. Involvement of jaw bone results in progressive enlargement causing facial asymmetry. The characteristic radiographic presentation of Paget's disease is 'cotton wool' appearance.

Histopathology (Fig. 19.2)

The lesions of Paget's disease show irregular trabeculae of mature lamellated bone with



Fibrous dysplasia (Photomicrograph 10X)

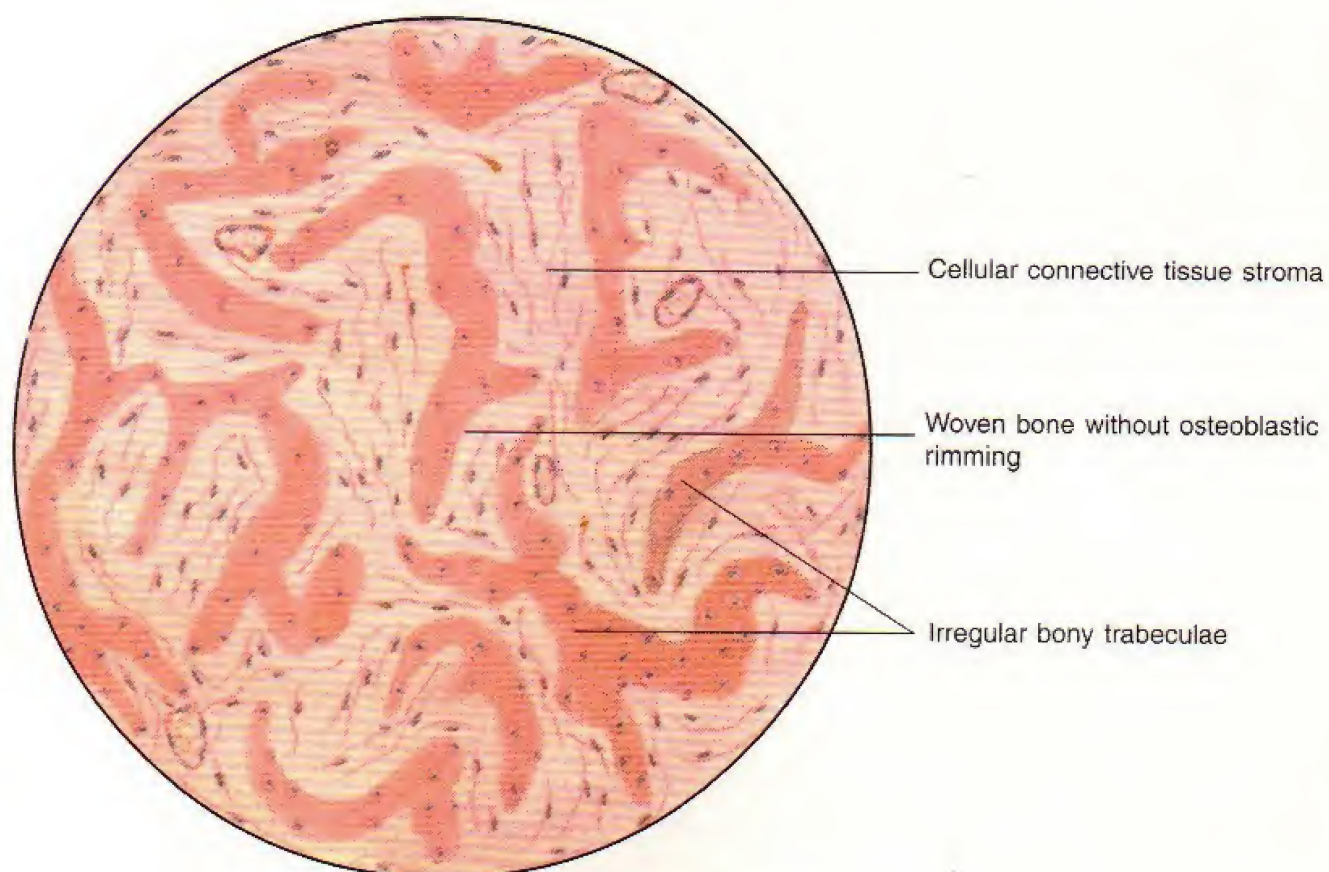


Fig. 19.1 Fibrous dysplasia

**Identification Points Fig. No. 19.2****PAGET'S DISEASE**

- Irregular trabeculae of mature lamellated bone
- Bony trabeculae having a 'mosaic pattern' and 'jigsaw - puzzle' appearance
- Osteoblastic rimming and areas of osteoclastic bone resorption

basophilic resting and reversal lines resulting in a 'jigsaw - puzzle' or 'mosaic pattern'. Bony trabeculae are lined by a layer of osteoid and plump osteoblasts. Osteoclasts resorbing bone is also a feature in the resorptive stage of the disease. Connective tissue stroma is vascular and tend to be fibrous.

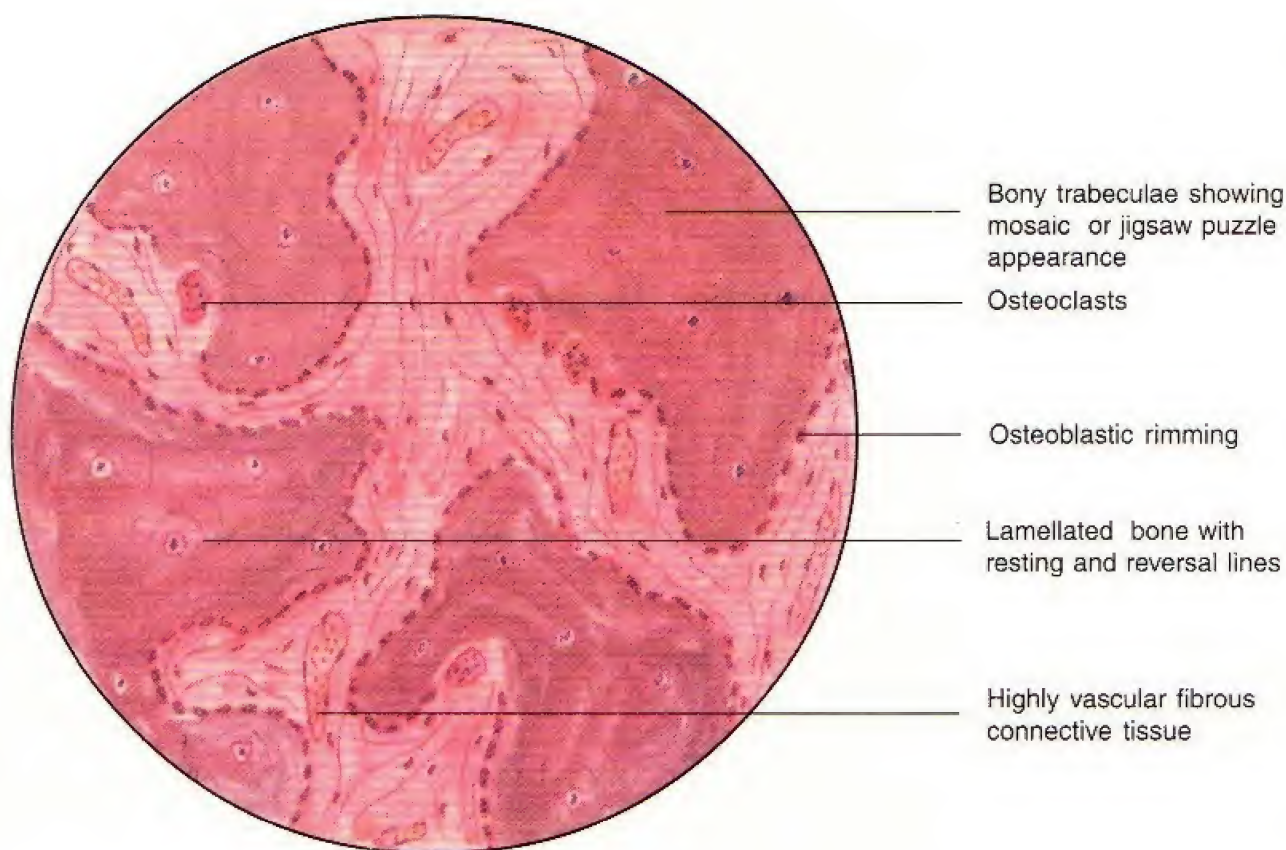


Fig. 19.2 Paget's disease

20

Benign and Malignant Tumors of Oral Cavity

- Benign epithelial tumors
- Premalignant lesions and conditions
- Malignant epithelial tumors
- Benign connective tissue tumors
- Malignant connective tissue tumors
- Tumor like lesions

Tumors of the oral cavity are classified into benign and malignant based on biological behavior. These tumors can originate from both epithelium and connective tissue.

BENIGN EPITHELIAL TUMORS

PAPILLOMA

Papilloma is the commonest benign epithelial tumor of the oral mucosa, that develops due to benign proliferation of stratified squamous epithelium. This lesion clinically presents as a painless exophytic growth with irregular cauliflower or wart like appearance.

Histopathology (Fig. 20.1)

Papilloma is characterized by finger like projections lined by hyperplastic stratified

squamous keratinized epithelium. Each finger like projection has a central thin connective tissue core carrying the blood vessels.



Identification Points Fig. No. 20.1

PAPILLOMA

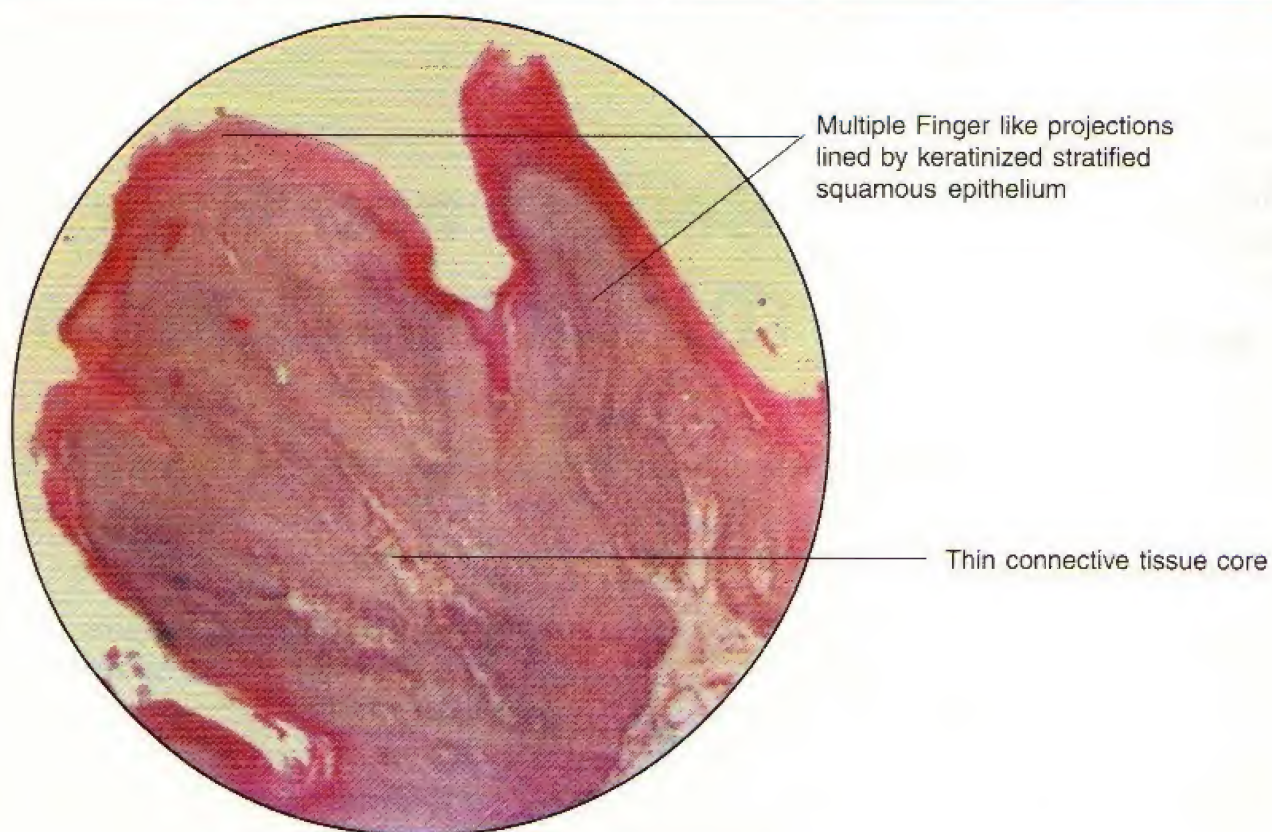
- Multiple finger like projections
- Hyperplastic stratified squamous epithelium lining the projections
- Connective tissue forms the core

MELANOTIC NEVUS

Melanotic nevus is a pigmented lesion which develops due to benign proliferation of nevus cells. Nevus cells are of neural crest origin and functionally similar to melanocytes with the capacity to produce melanin. Unlike melanocytes, nevus cells are not dendritic cells.

Histopathology

Histopathologically melanotic nevus is characterized by proliferation of small ovoid nevus cells arranged to form small round



Papilloma (Photomicrograph 10X)

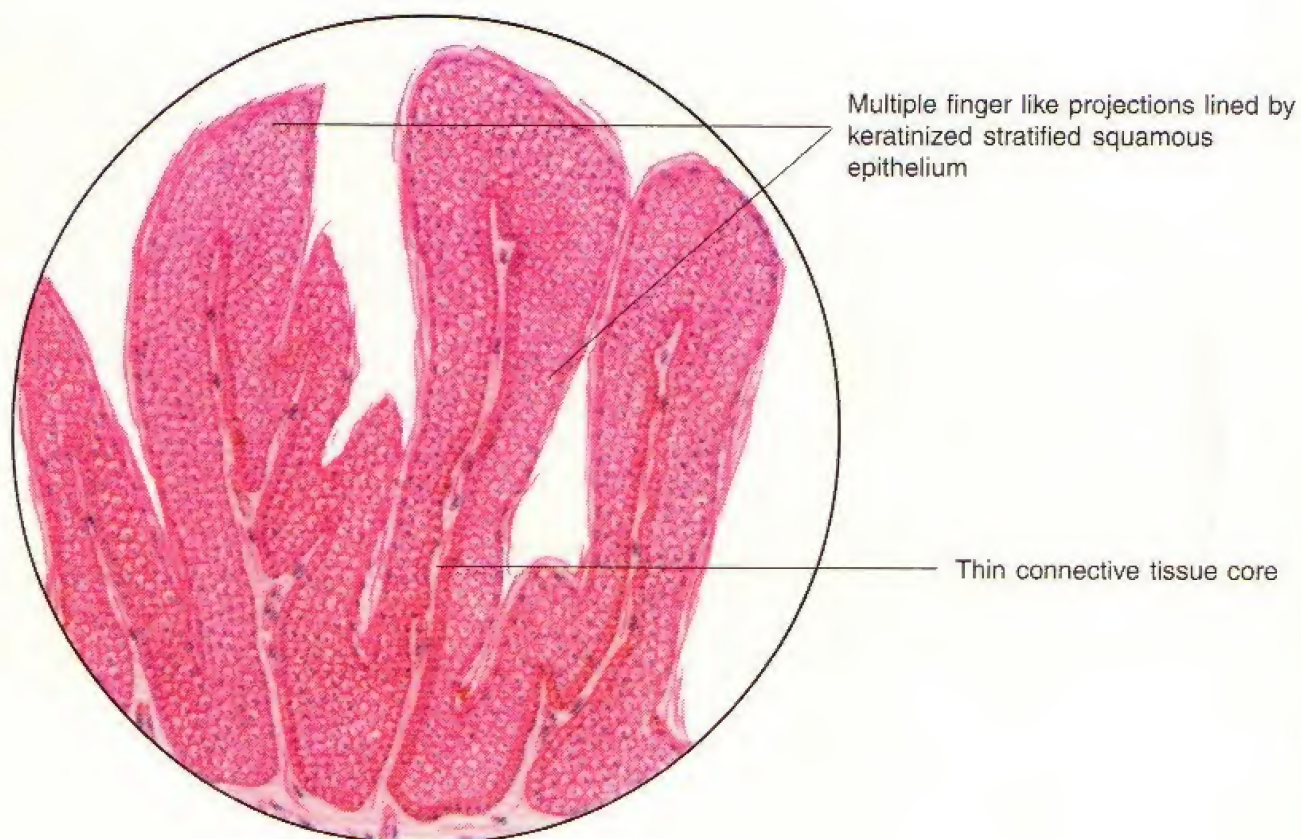


Fig. 20.1 Papilloma

aggregates. These are called theques. Nevus cells have small uniform nucleus with eosinophilic cytoplasm and indistinct cell boundaries.

Based on location of proliferating nevus cells histopathologically melanotic nevus is divided in to -

1. **Junctional nevus (Fig. 20.2)**- Nevus cells are arranged in the form of theques in the basal layers of epithelium especially at the tip of rete ridges. Here the nevi cells are seen



Identification Points Fig. No. 20.2

JUNCTIONAL NEVUS

- Nevus cells restricted to epithelium
- Nevus cells arranged to form theques in the basal layer
- 'Abtropfung' or 'dropping off' effect may be seen

in the junction between epithelium and connective tissue. Junctional activity may be seen with few cells crossing junction and growing down into connective tissue, which is described as 'abtropfung effect'.

2. **Compound nevus (Fig. 20.3)**- In this nevus cell proliferation is seen both in epithelium and connective tissue.



Identification Points Fig. No. 20.3

COMPOUND NEVUS

- Proliferating nevus cells in epithelium
- Nests of nevus cells dropping off from the epidermis
- Nests of nevus cells in the connective tissue also

3. **Intradermal Nevus/ Intramucosal nevus (Fig. 20.4)**: Nevus cells are found only in

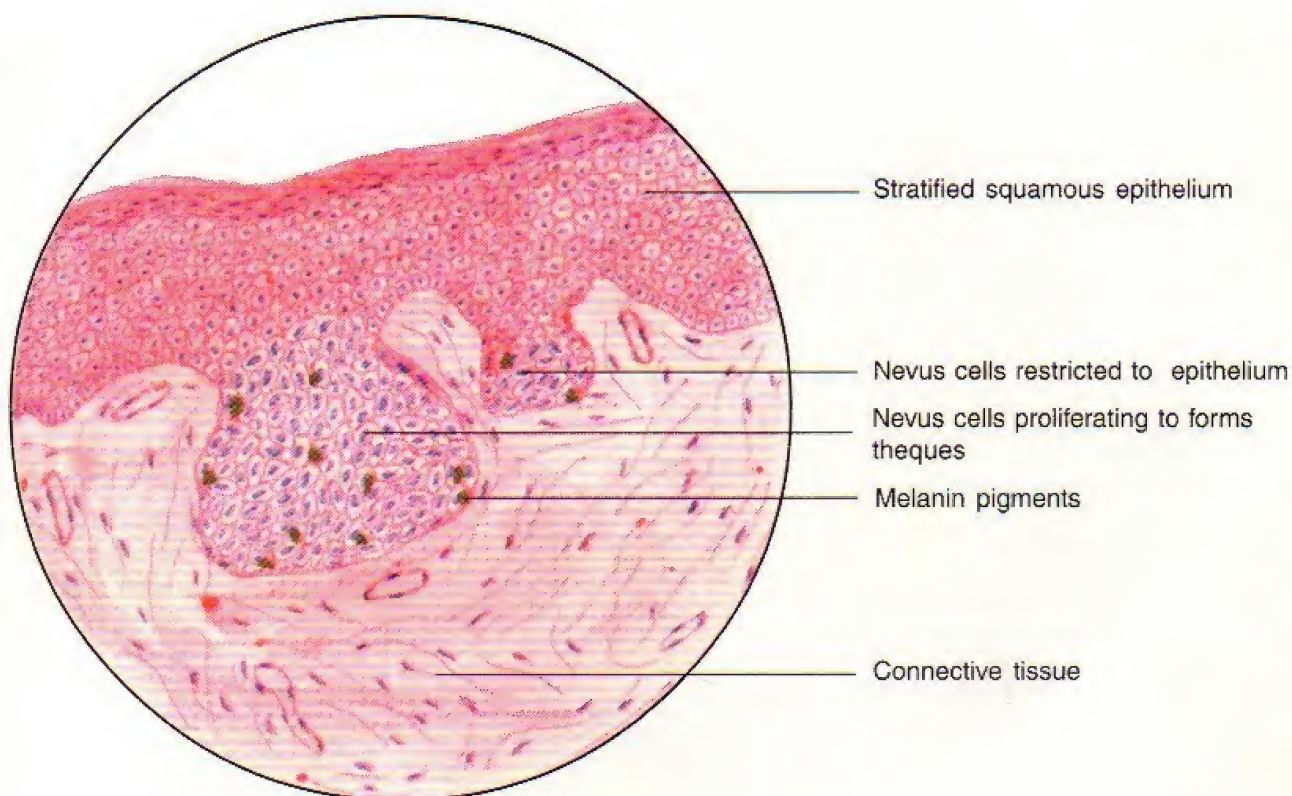


Fig. 20.2 Junctional Nevus

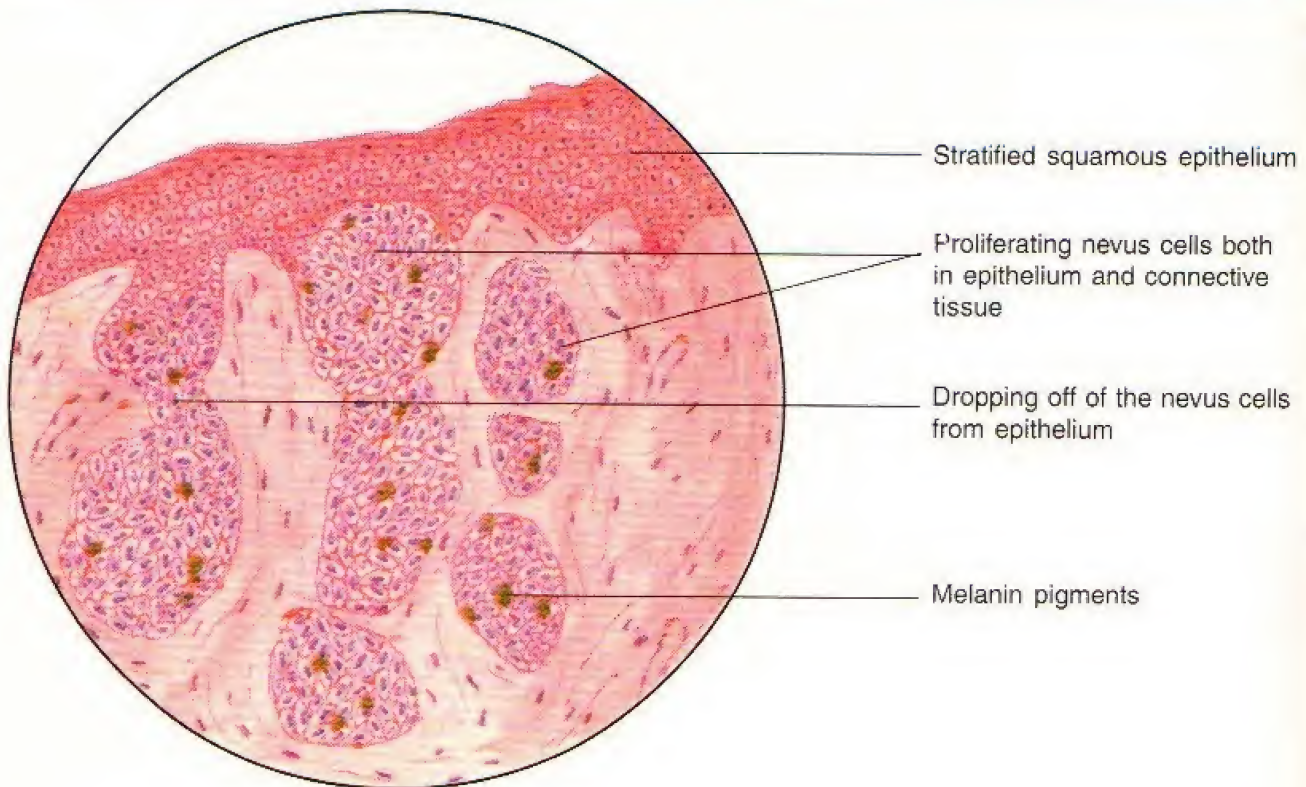


Fig. 20.3 Compound Nevus

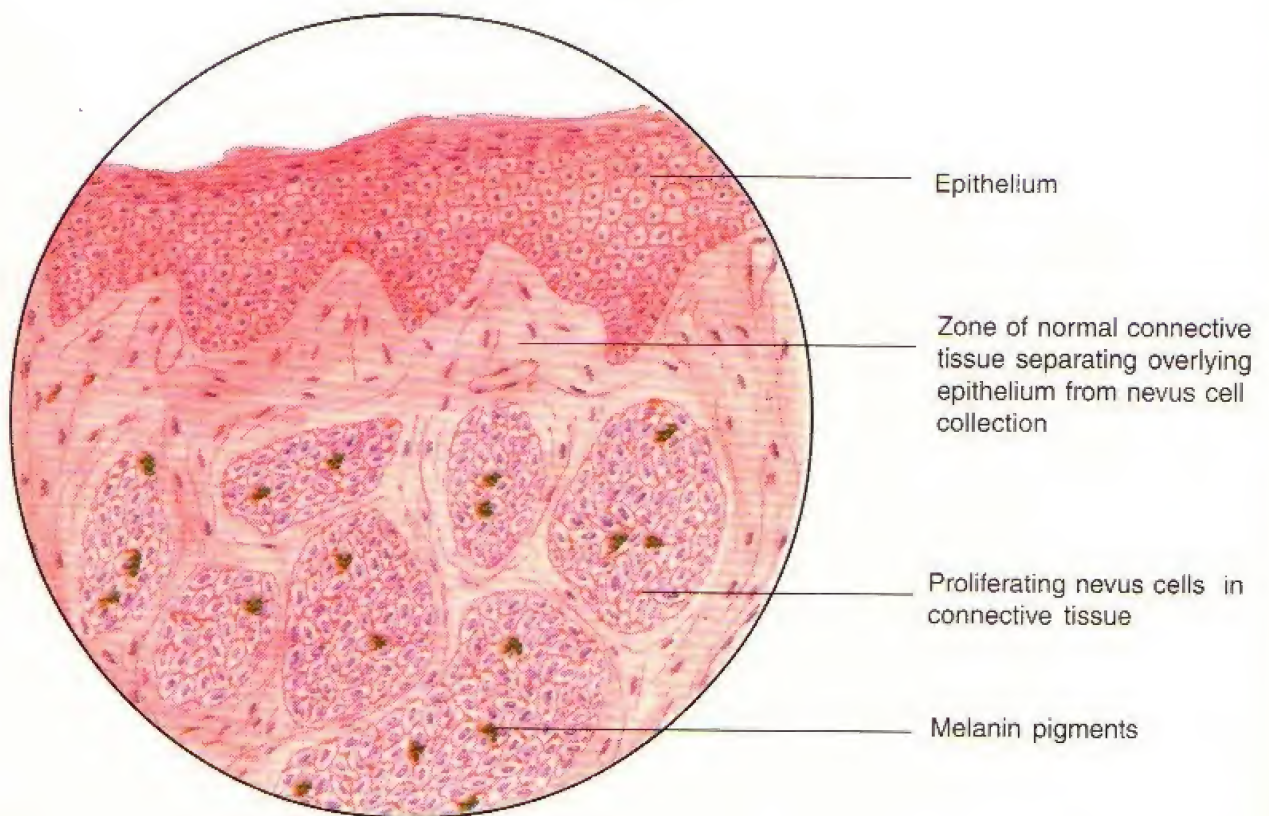


Fig. 20.4 Intradermal nevus


Identification Points Fig. No. 20.4
INTRADERMAL NEVUS

- Nests of nevus cells in the connective tissue
- Three types of cells are seen; - epithelioid, lymphocyte like and spindle shaped.
- Zone of connective tissue separates nevus cells from overlying epithelium

the connective tissue. A zone of normal connective tissue is seen which separates the nevus cells from the overlying epithelium. In intra mucosal nevus 3 types of cell are seen -

- Peripheral type A - epithelioid cells
- Central type B - lymphocyte like cells
- Deeper type C - spindle shaped cells

PRECANCEROUS LESIONS

Precancerous lesion is defined as a benign, morphologically altered tissue in which cancer is more likely to develop than its apparently normal counterpart.

LEUKOPLAKIA

Leukoplakia is the commonest precancerous lesions that occur in the oral cavity. It is manifested as a white patch or plaque that cannot be scraped off or rubbed off. Malignant transformation potential is 6-7%.

Histopathology (Fig. 20.5)

Microscopically leukoplakia is characterized by

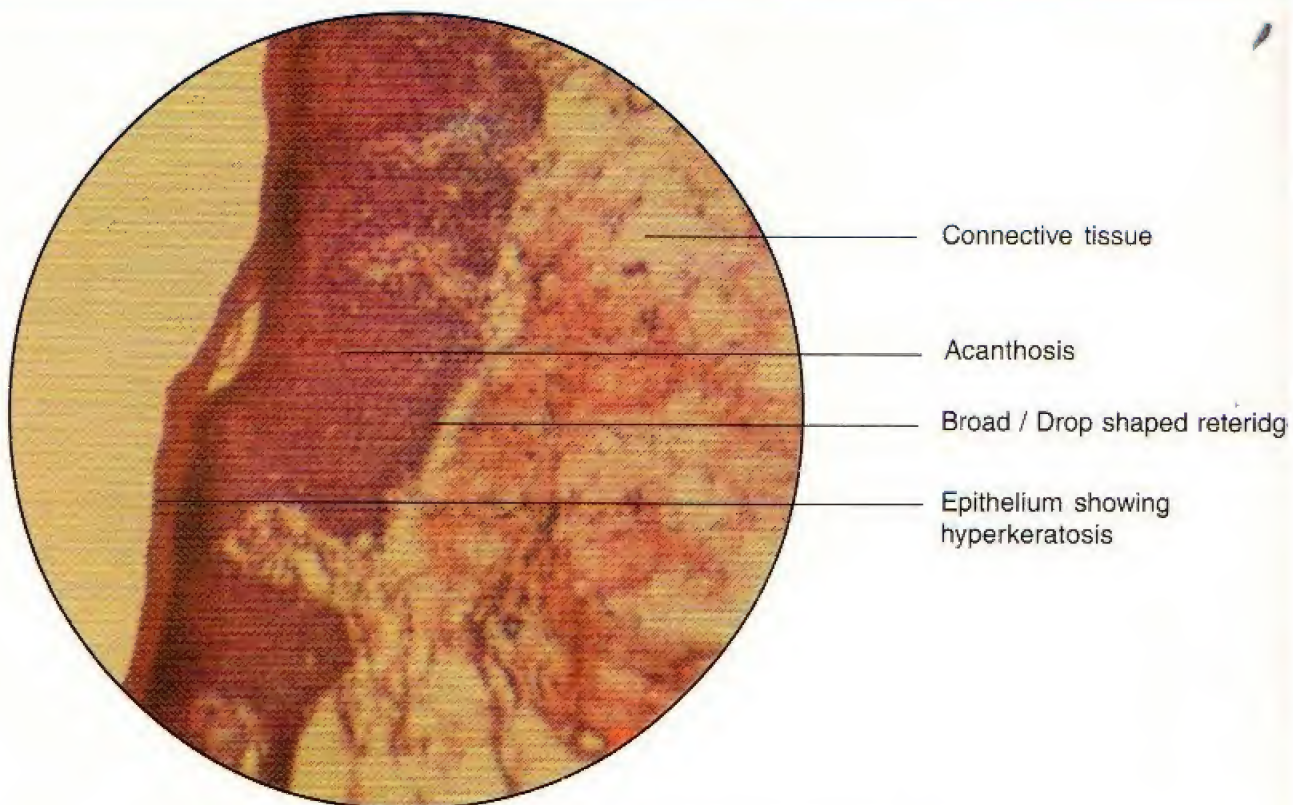
1. **Hyperkeratosis** - thickened keratin layer which may be parakeratotic or

orthokeratotic. In case of hyper orthokeratosis a prominent granular layer is seen. Surface of epithelium may be smooth or irregular with papillary projection (verrucous leukoplakia).

2. **Acanthosis** - most of leukoplakic lesions show thickening of spinous layer which is termed as acanthosis. Some of the leukoplakic lesions may show areas of epithelial atrophy.

3. **Dysplastic features** - The lesions of leukoplakia show dysplastic features of different grades. The features of epithelial dysplasia are -

- **Bulbous or drop shaped rete ridges** - Normally the rete ridges taper to the deeper portion or are parallel sided with blunt ends. In dysplasia the deepest portion of rete ridges become wider. This occurs to accommodate the increased number of cells.
- **Basal cell hyperplasia** - Normally basal cell layer has one to two layers of cells. In dysplasia the basal cell layer increases to more than two layers thick.
- **Loss of polarity of basal cells** - Normally the nucleus of basal cells is arranged perpendicular to the basement membrane. When this arrangement is lost, the nuclei are in different angles. This is called loss of polarity.
- **Irregular epithelial stratification** - In normal epithelium distinct layers (strata) are seen. Disturbance in this arrangement is called irregular stratification.
- **Loss of intercellular adhesion** - In normal epithelium the cells are attached to each other by desmosomes. As the dysplasia progresses the cell loses their attachment to each other due to desmosomal changes.



Leukoplakia (Mild Dysplasia) (Photomicrograph 10X)

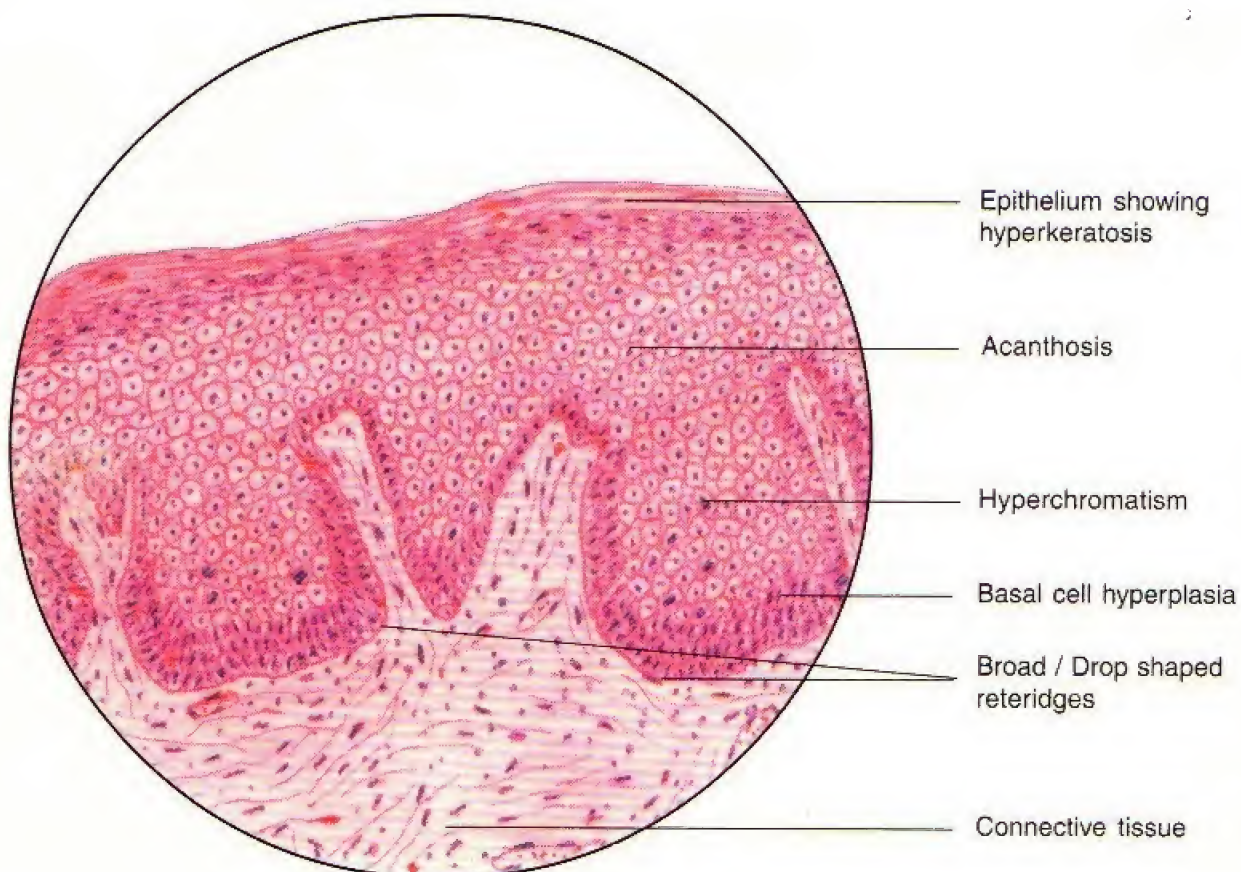


Fig.20.5 Leukoplakia (Mild Dysplasia)

- **Cellular pleomorphism or anisocytosis** - In dysplastic epithelium cells show variation in shape and size.
- **Alteration in nuclear cytoplasmic ratio** - Normal ratio between nucleus and cytoplasm is 1: 4 or 1: 6. When the nucleus increases in size, in dysplasia the nuclear cytoplasmic ratio changes to 1:1.
- **Nuclear hyperchromatism** - Hyperchromatism is increased or dark staining of nucleus. This occurs, due to increased DNA content of highly active cells in dysplasia.
- **Prominent nucleoli**- In dysplastic epithelial cells nucleoli become prominent and larger.
- **Increased mitosis** - In dysplasia due to active division of cells more number of mitotic figures are seen when compared to normal epithelium.
- **Level of mitosis** - In normal epithelium only basal and para basal cells have the ability of mitotic division. In dysplastic epithelium mitotic activity is seen even in higher levels of epithelium.
- **Abnormal mitosis** - Mitotic figures in various forms other than normal is seen in dysplastic epithelium. e.g. Tripolar mitotic figures.
- **Dyskeratosis or abnormal keratinization**- Normally keratinization occurs only in the superficial layers of epithelium. In dysplasia keratinization

of individual cells or even keratin pearl formation is seen in deeper layers.

Epithelial dysplasia is graded into mild (when dysplastic changes are confined to basal 1/3rd of epithelium), moderate (up to 2/3rd of epithelium showing dysplastic changes), severe (more than 2/3rd of epithelium showing dysplastic changes but less than the entire thickness).

CARCINOMA IN SITU (INTRA - EPITHELIAL CARCINOMA) (Fig. 20.6)

This is a histological term used to describe an epithelium which is exhibiting dysplastic changes throughout its thickness (top to bottom changes). In this, dysplastic features are evident from basal cell layer to the superficial layer, but strictly restricted to the epithelium. The basement membrane is intact.



Identification Points Fig. No. 20.6

CARCINOMA IN SITU

- Top to bottom dysplastic changes from basal layer to superficial layer
- Intact basement membrane

PRECANCEROUS CONDITIONS

Precancerous condition is defined as a disease or patient habit that does not necessarily alter the clinical appearance of local tissue, but is associated with the greater than normal risk of precancerous lesions or cancer to develop in that tissue.

ORAL SUBMUCOUS FIBROSIS

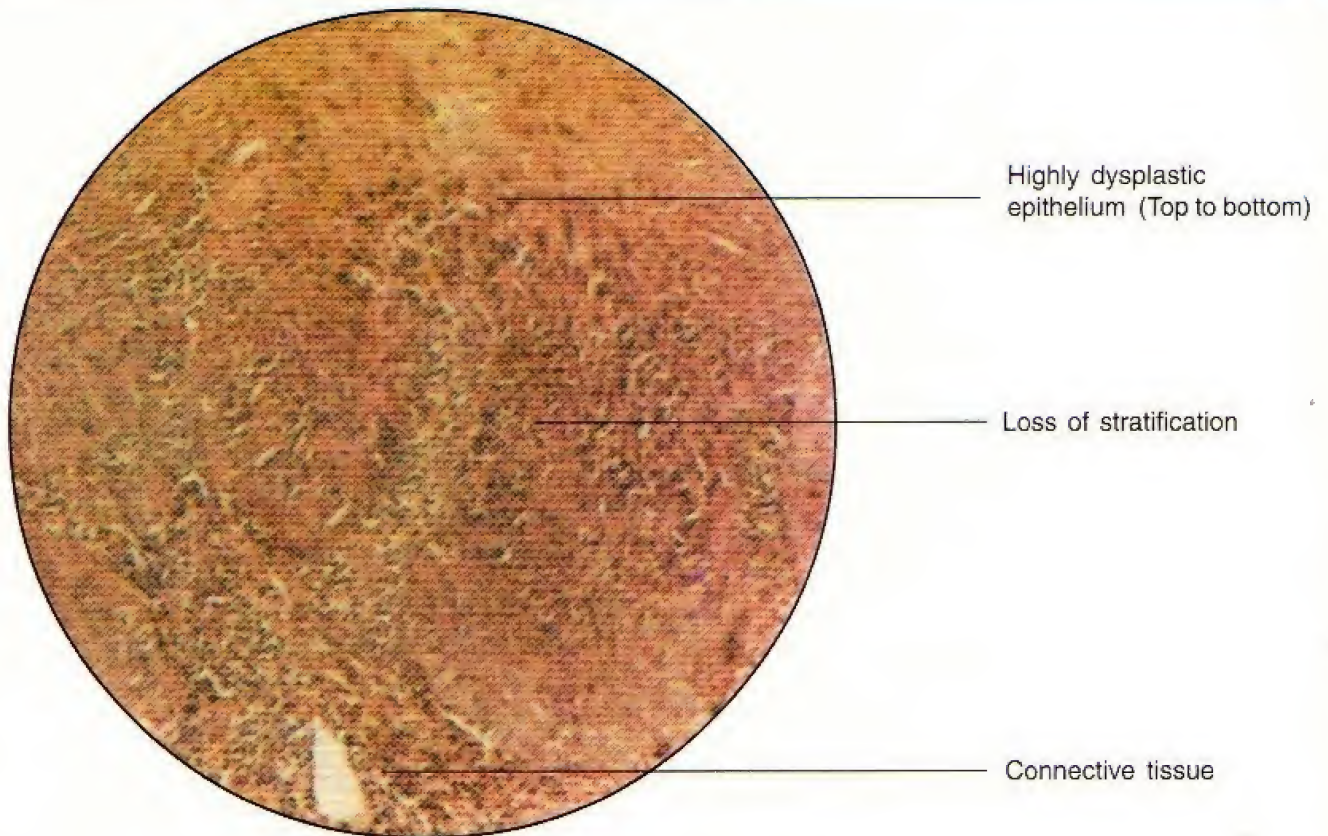
This is a common precancerous condition seen



Identification Points Fig. No. 20.5

LEUKOPLAKIA

- Hyper keratosis
- Acanthosis
- Dysplastic features in the epithelium



Carcinoma in situ (Photomicrograph 10X)

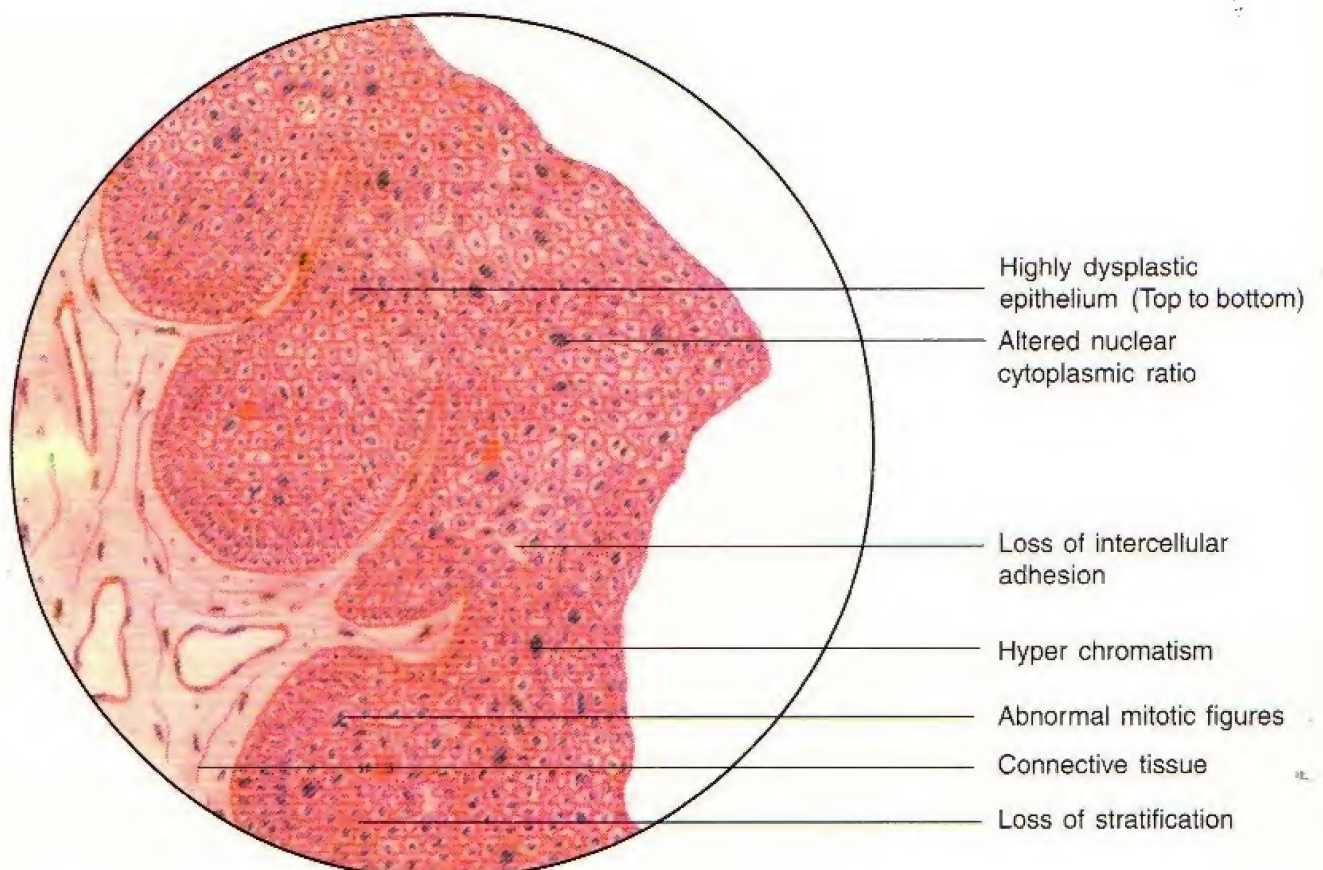
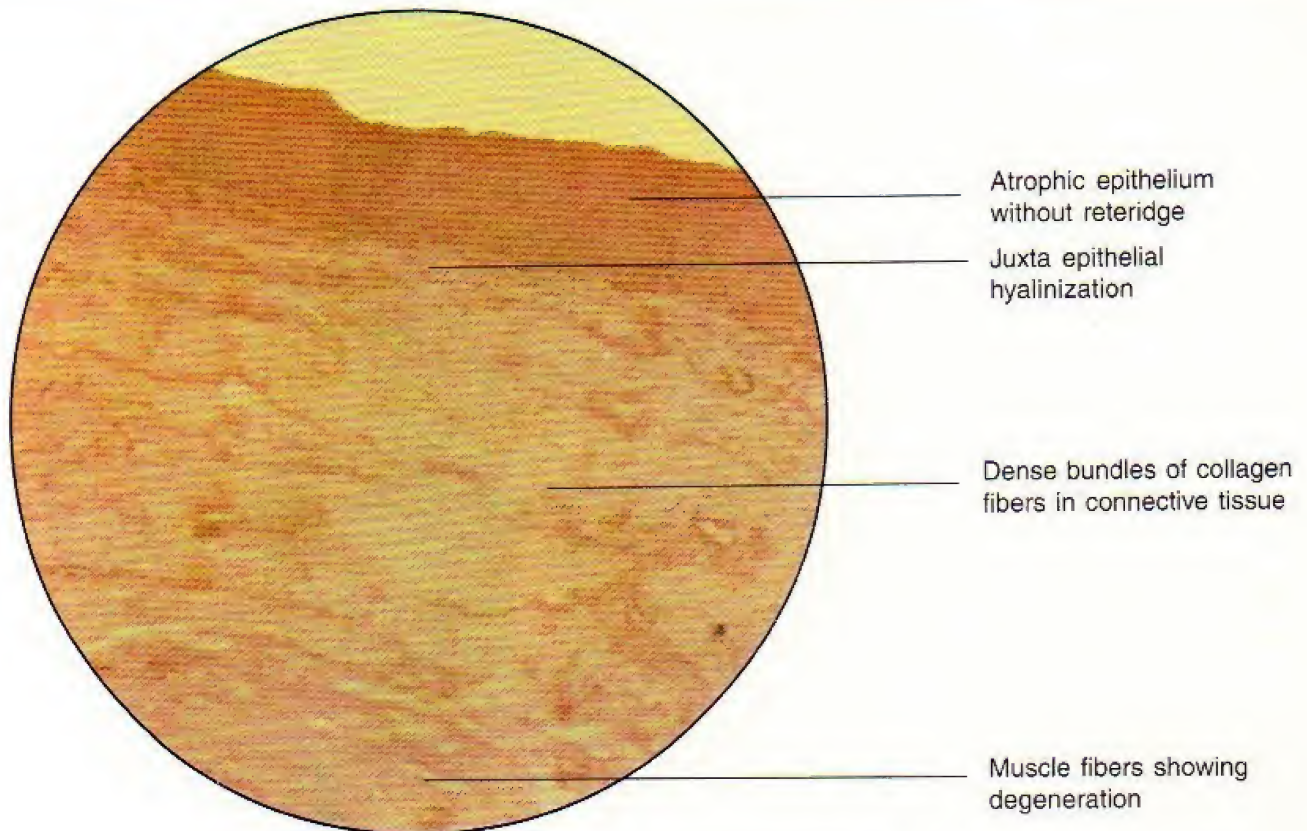


Fig.20.6 Carcinoma in situ



Oral submucous fibrosis (Photomicrograph 10X)

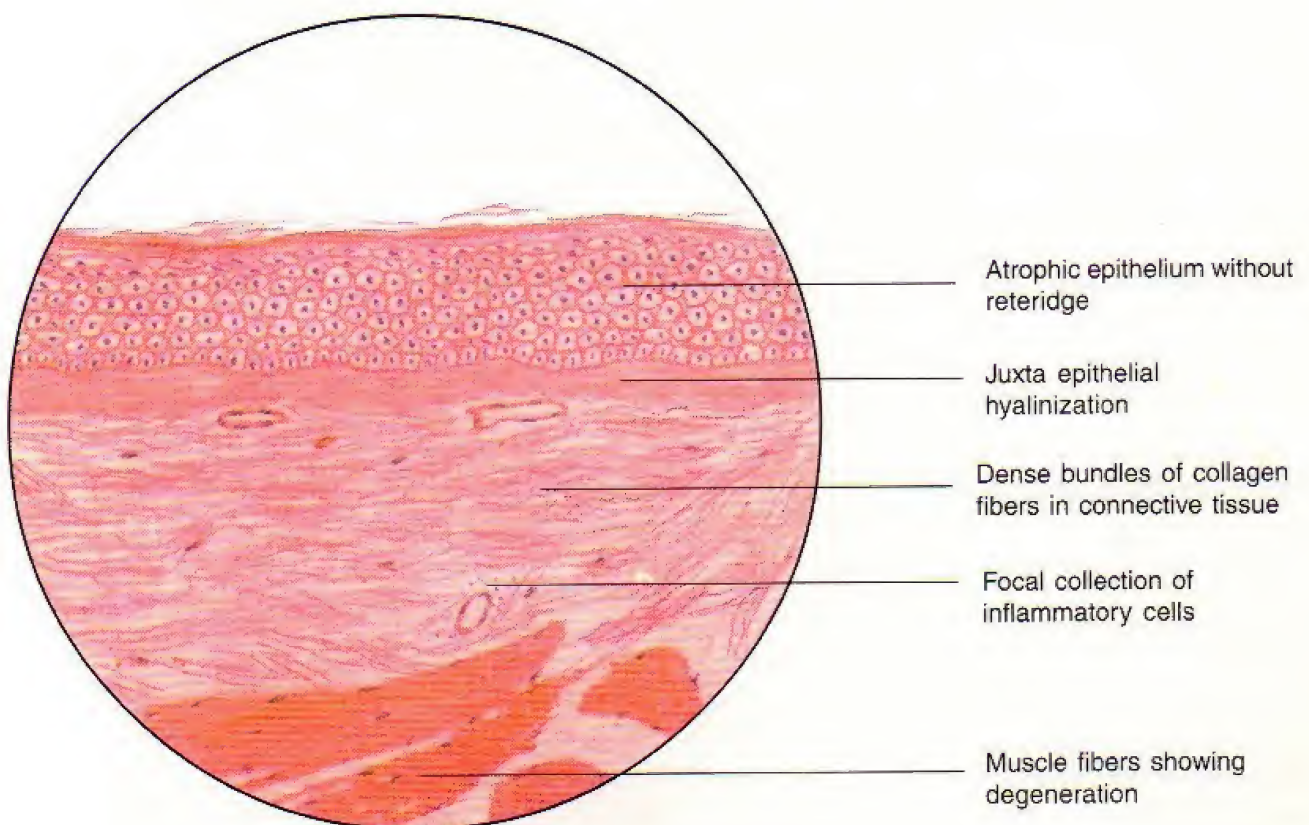


Fig. 20.7 Oral submucous fibrosis

in India, related to betel quid chewing. This disease is characterized by progressive mucosal rigidity caused by fibrosis of connective tissue.

Histopathology (Fig. 20.7)

In oral submucous fibrosis the epithelium is atrophic with short or flat rete ridges. Connective tissue just beneath the epithelium shows hyalinization (juxta - epithelial hyalinization). Connective tissue exhibits fibrosis with dense bundles of collagen fibers. Because of fibrosis of connective tissue the blood vessels become narrow. Focal collections of chronic inflammatory cells are present. In severe cases muscle undergoes degenerative changes.



Identification Points Fig. No. 20.7

ORAL SUBMUCOUS FIBROSIS

- Atrophic epithelium
- Juxta - epithelial hyalinization
- Fibrosed connective tissue

MALIGNANT EPITHELIAL TUMORS

SQUAMOUS CELL CARCINOMA

Squamous cell carcinoma or epidermoid carcinoma is the commonest epithelial malignancy that occur in the oral cavity. Clinically these lesions may manifest as ulcers, exophytic growth and red or white patches of oral mucosa.

Histopathology

The most significant microscopic feature of squamous cell carcinoma is dysplastic epithelial cells invading in to the connective tissue. These cells may be arranged in the form of cords, sheets or islands. Dysplastic features seen are hyper

chromatism of nuclei, alteration of nuclear cytoplasmic ratio, pleomorphism of cells and nuclei, prominent nucleoli, many normal and abnormal mitotic figures, individual cell keratinization and keratin pearl formation. Overlying epithelium will be highly dysplastic and a break in basement membrane can be seen allowing the cells to invade into connective tissue.

Squamous cell carcinoma is graded histologically based on degree of differentiation (keratin formation), dysplastic changes of cells, depth of invasion and host response.

1. **Well differentiated (Fig. 20.8a):** Highly keratinized, with multiple keratin pearl formation and few cells showing atypical changes. These lesions have well delineated infiltrating boarder and marked lymphocytic infiltration of connective tissue.



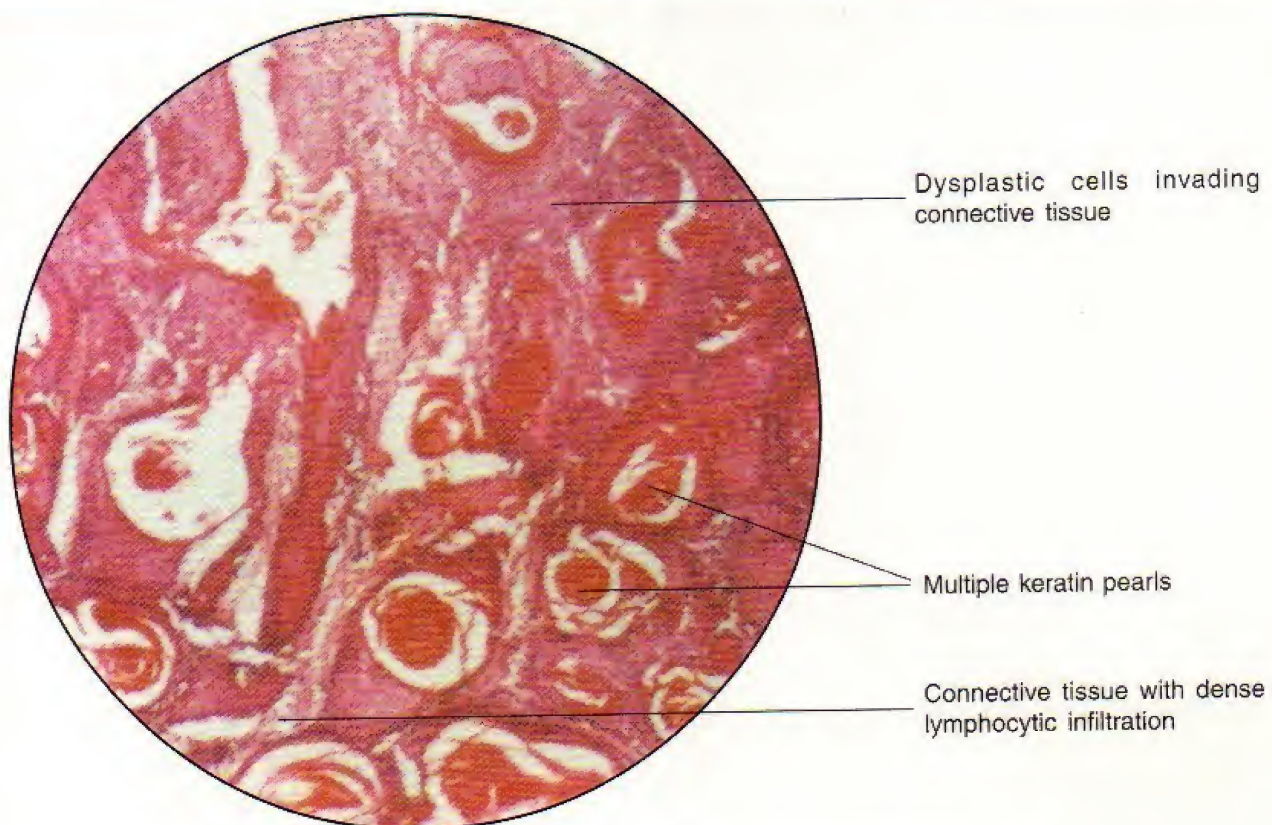
Identification Points Fig. No. 20.8a

SQUAMOUS CELL CARCINOMA (WELL DIFFERENTIATED)

- Break in basement membrane
- Dysplastic cells invading connective tissue
- Well differentiated cells with multiple keratin pearl formation

2. **Moderately differentiated (Fig. 20.8b):** Moderately keratinized, with few keratin pearls. More cells showing atypical changes. Dysplastic cell infiltration is seen in the superficial connective tissue in the form of strands and islands with moderate lymphocytic infiltration.

3. **Poorly Differentiated (Fig. 20.8c):** Minimal keratinization with scanty keratin pearls and abundant atypical changes with more than 50% of the cells showing changes. Small group of cells infiltrating



Squamous cell carcinoma - well differentiated (Photomicrograph 10X)

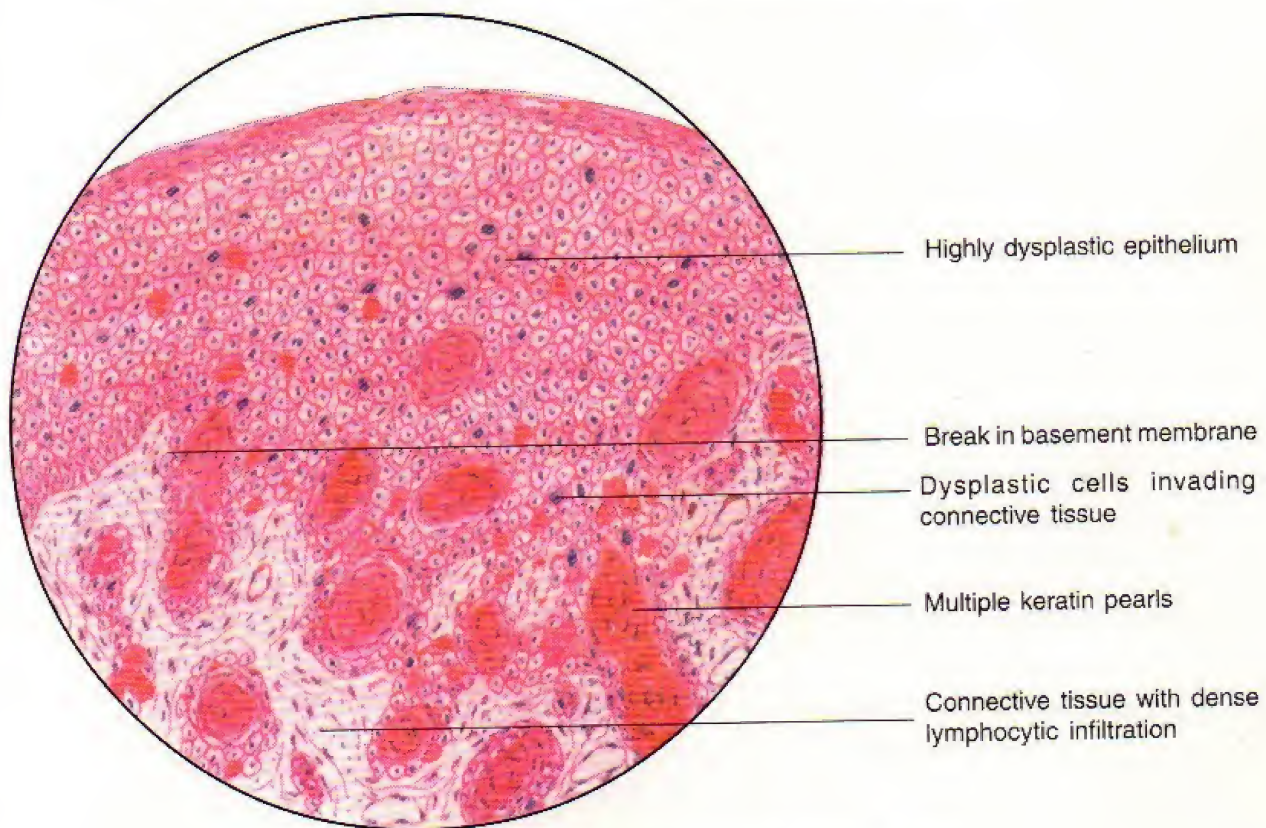
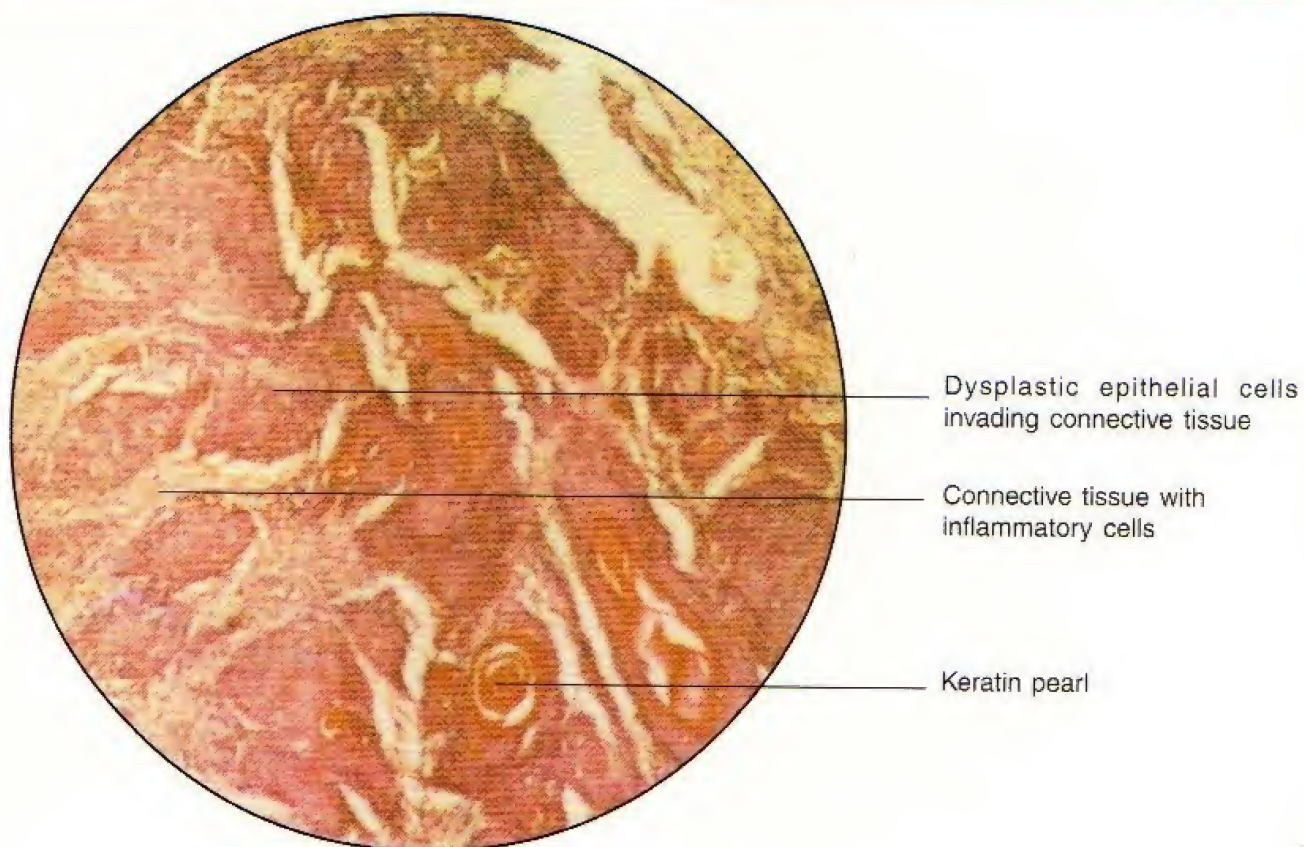


Fig.20.8a Squamous cell carcinoma - well differentiated



Squamous cell carcinoma- Moderately differentiated (Photomicrograph 10X)

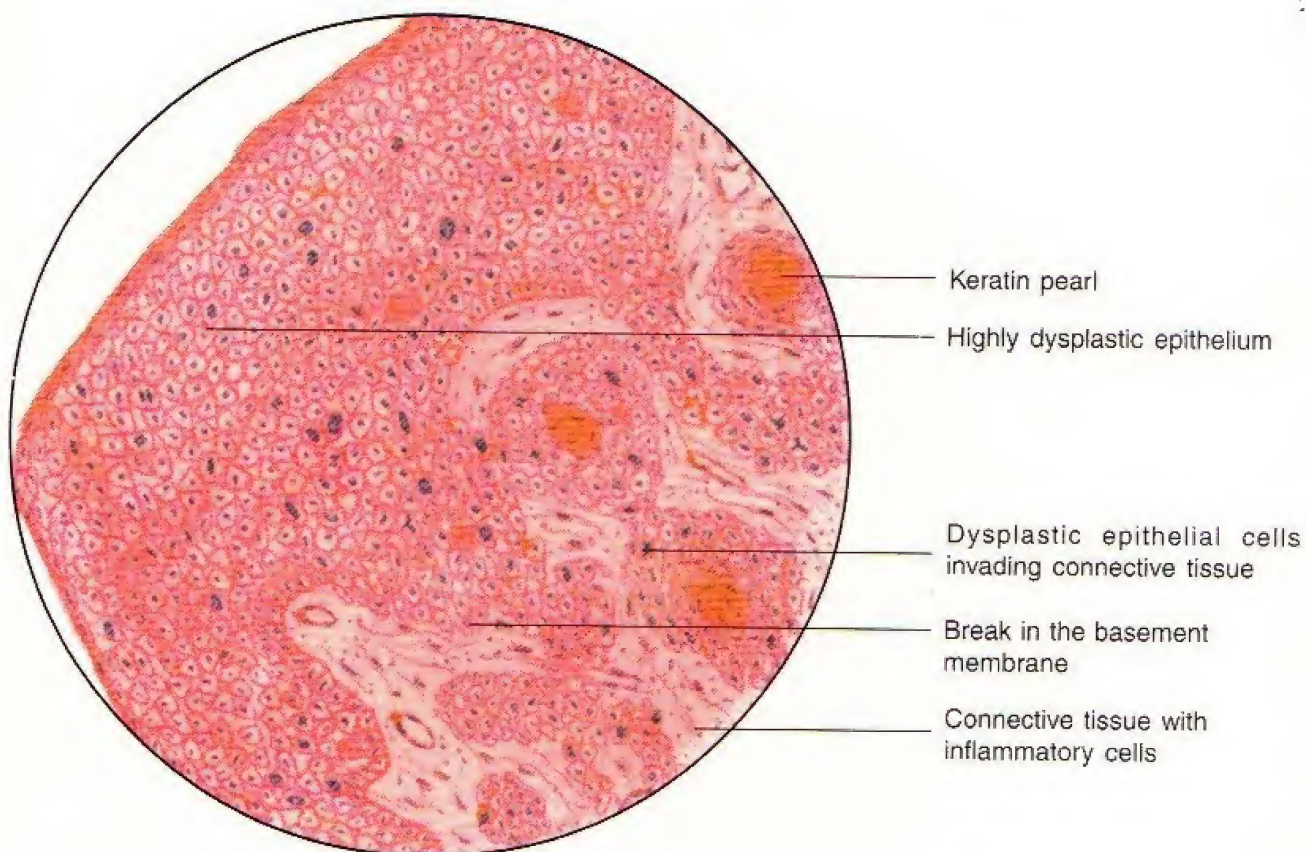
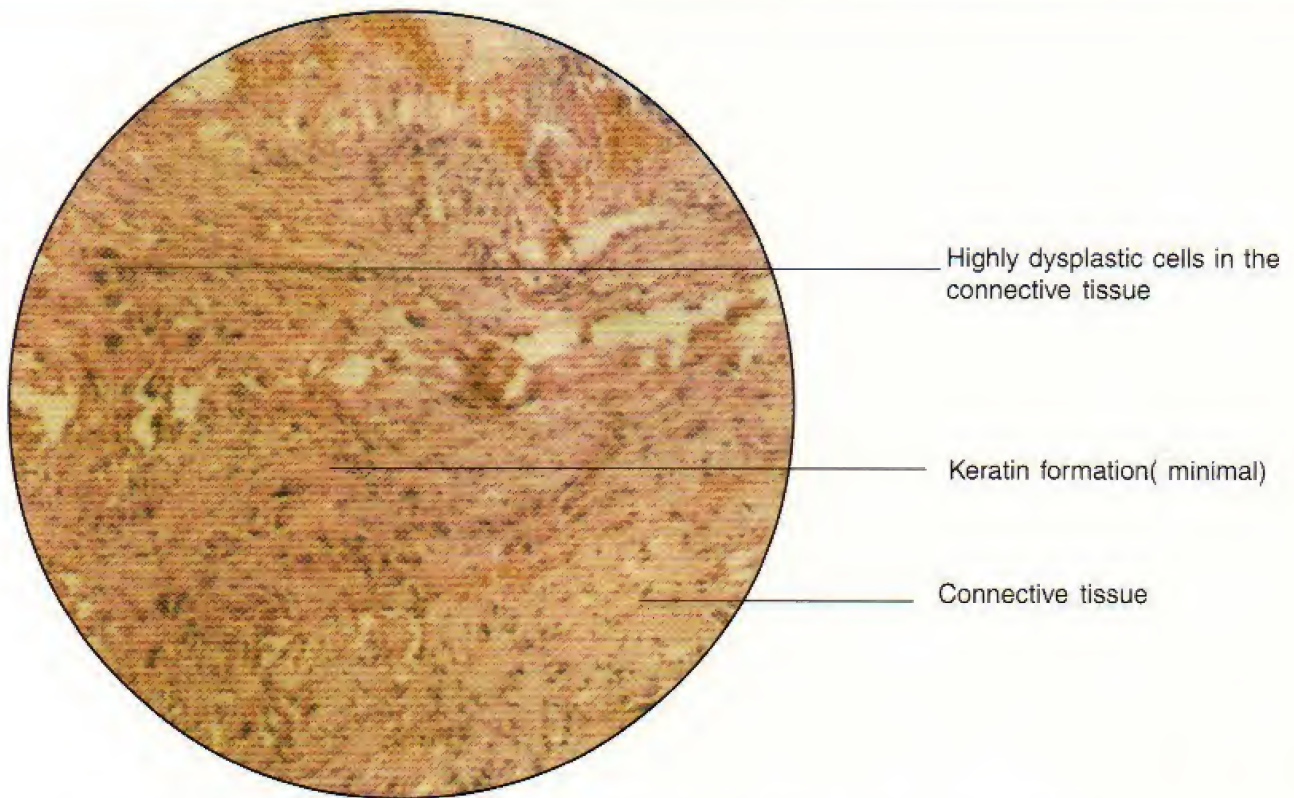


Fig. 20.8b Squamous cell carcinoma- Moderately differentiated



Squamous cell carcinoma - poorly differentiated (Photomicrograph 10X)

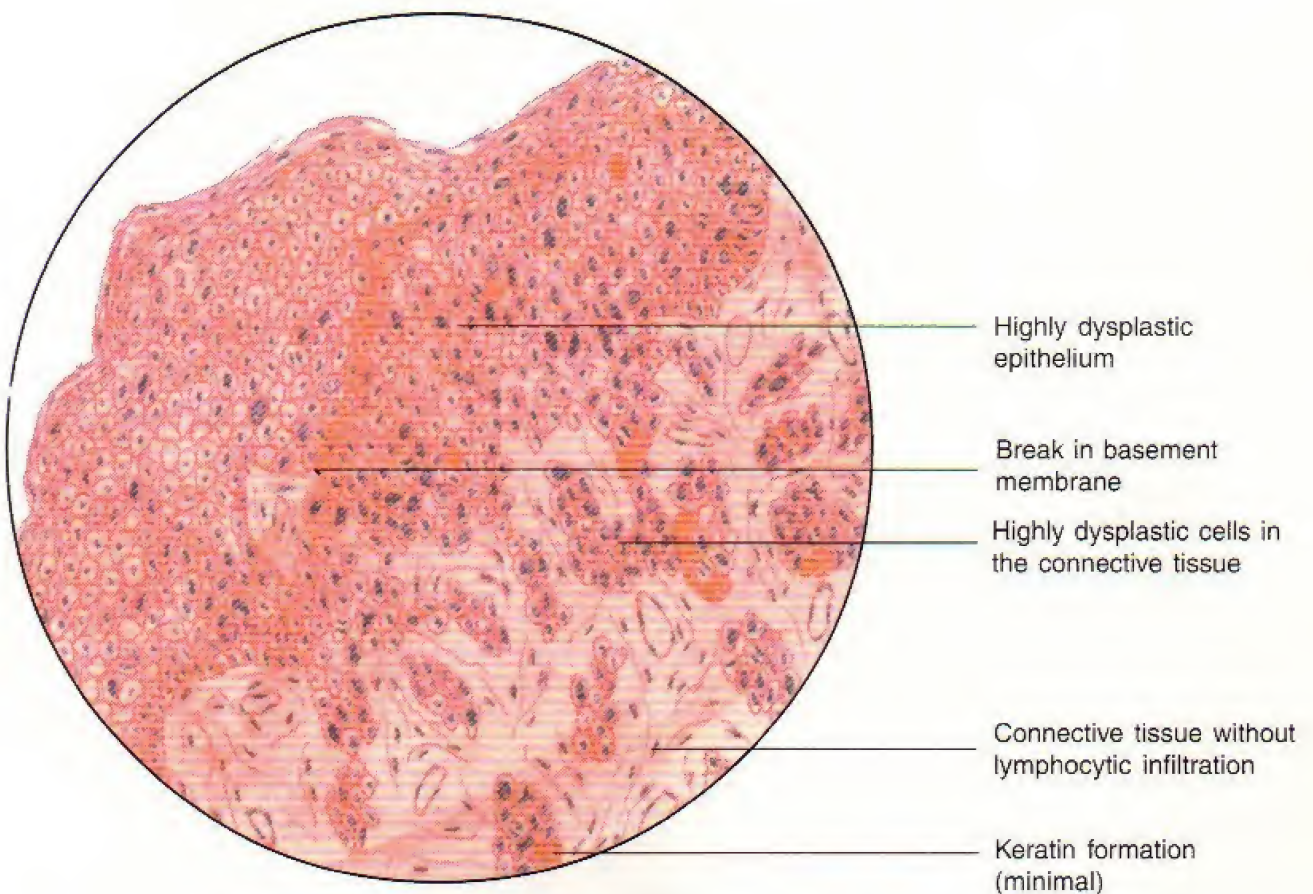


Fig.20.8c Squamous cell carcinoma - poorly differentiated

KEY**Identification Points Fig. No. 20.8b****SQUAMOUS CELL CARCINOMA
(MODERATELY DIFFERENTIATED)**

- Break in basement membrane
- Dysplastic cells invading connective tissue
- Moderately differentiated cells with few keratin pearl formation

KEY**Identification Points Fig. No. 20.8c****SQUAMOUS CELL CARCINOMA
(POORLY DIFFERENTIATED)**

- Break in basement membrane
- Dysplastic cells invading connective tissue
- Poorly differentiated cells with scanty keratinization

deep into the connective tissue with atypical cells being found adjacent to muscle and salivary gland. Connective tissue shows only very minimal lymphocytic infiltration.

4. **Anaplastic carcinoma:** Extreme cellular atypia but no differentiation or keratinization. Single or small group of cells invade deep in to the connective tissue replacing most of the stromal cells. No lymphocytic infiltration is seen in the connective tissue.

VERRUCOUS CARCINOMA

It is a low grade variant of squamous cell carcinoma which commonly manifest as painless, thick plaque with a warty or verrucous surface.

Histopathology (Fig. 20.9)

Epithelium is hyperplastic with minimal cellular atypia. The rete ridges are broad with pushing

KEY**Identification Points Fig. No. 20.9****VERRUCOUS CARCINOMA**

- Hyperplastic epithelium with minimal dysplastic features
- Broad rete ridges with pushing border
- Intact basement membrane
- Chronic inflammatory cells in the connective tissue

border in to the deeper connective tissue described as 'elephant foot' shaped rete ridges. Epithelium is hyper keratotic with numerous clefts filled with parakeratin (parakeratin plugging) that extends into deep spinous cell layer. Basement membrane is intact. Frequently the connective tissue exhibits dense chronic inflammatory cell infiltration.

**BASAL CELL CARCINOMA
(RODENT ULCER)**

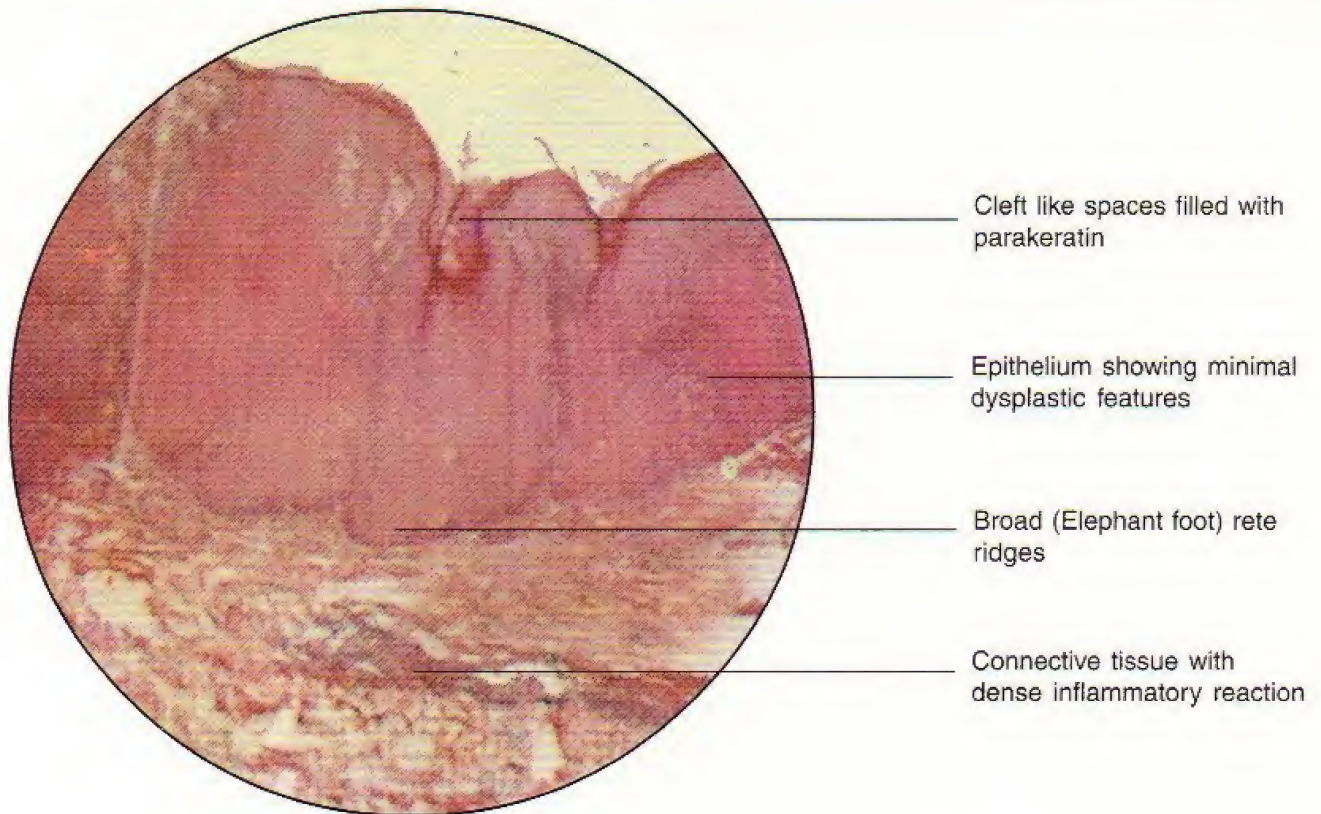
This is an epithelial malignancy arising from the basal layer of skin and its appendages. Clinically this lesion begins as nodules that ulcerate with a rolled out border. The lesion invades into deeper tissue like a rodent. In the oral cavity basal cell carcinoma is not seen unless infiltrated from overlying skin.

Histopathology (Fig. 20.10)

Basal cell carcinoma is characterized by islands,

KEY**Identification Points Fig. No. 20.10****BASAL CELL CARCINOMA**

- Islands of epithelial cells invading connective tissue
- Cells resemble basal cells
- Peripheral cells having palisading arrangement of nuclei.



Verrucous carcinoma (Photomicrograph 10X)

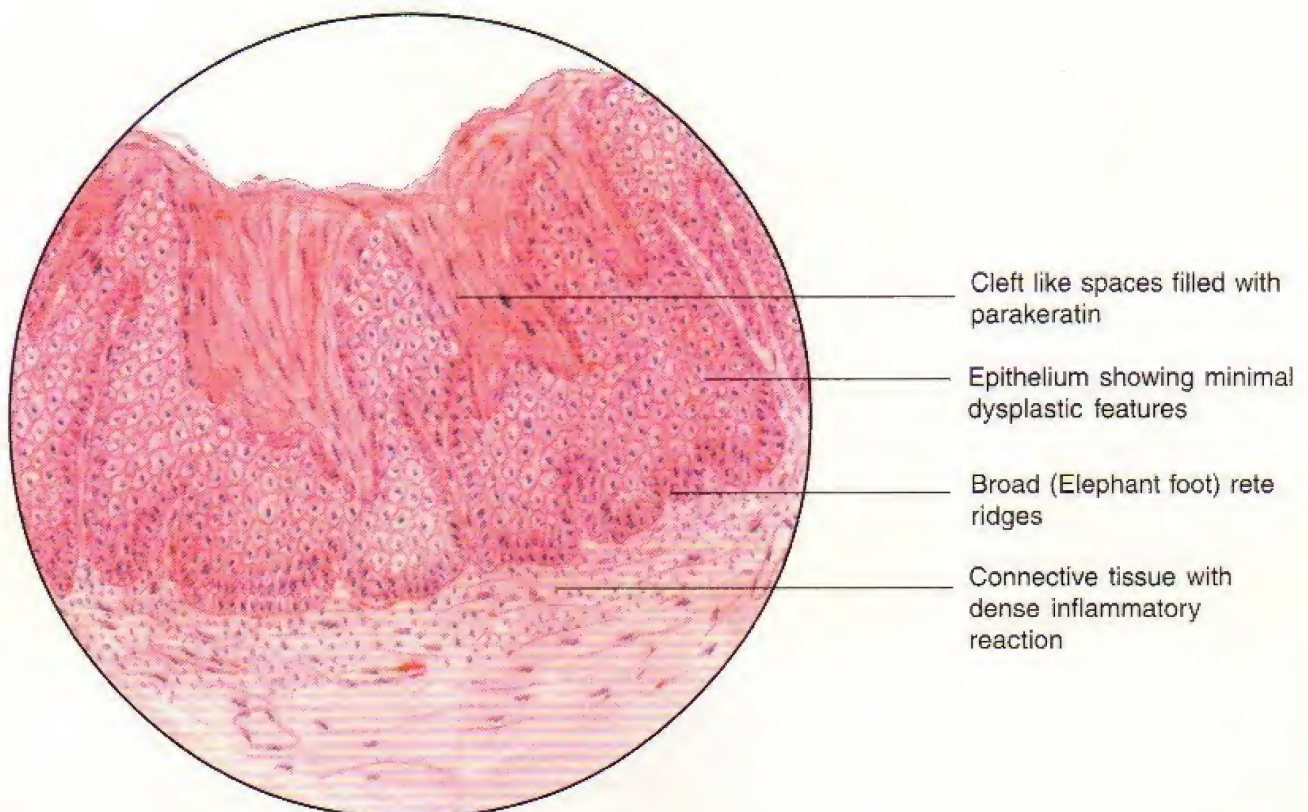
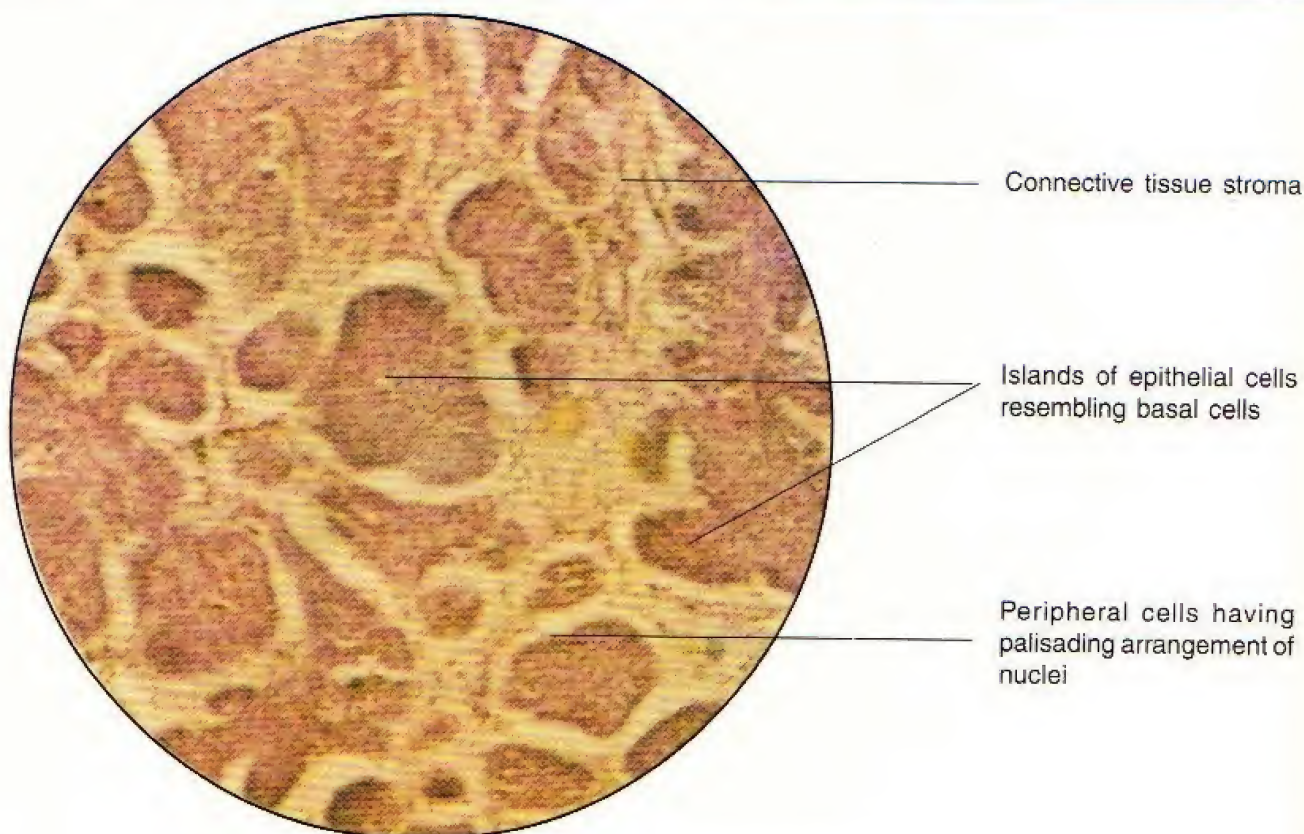


Fig.20.9 Verrucous carcinoma



Basal cell carcinoma (Photomicrograph 10X)

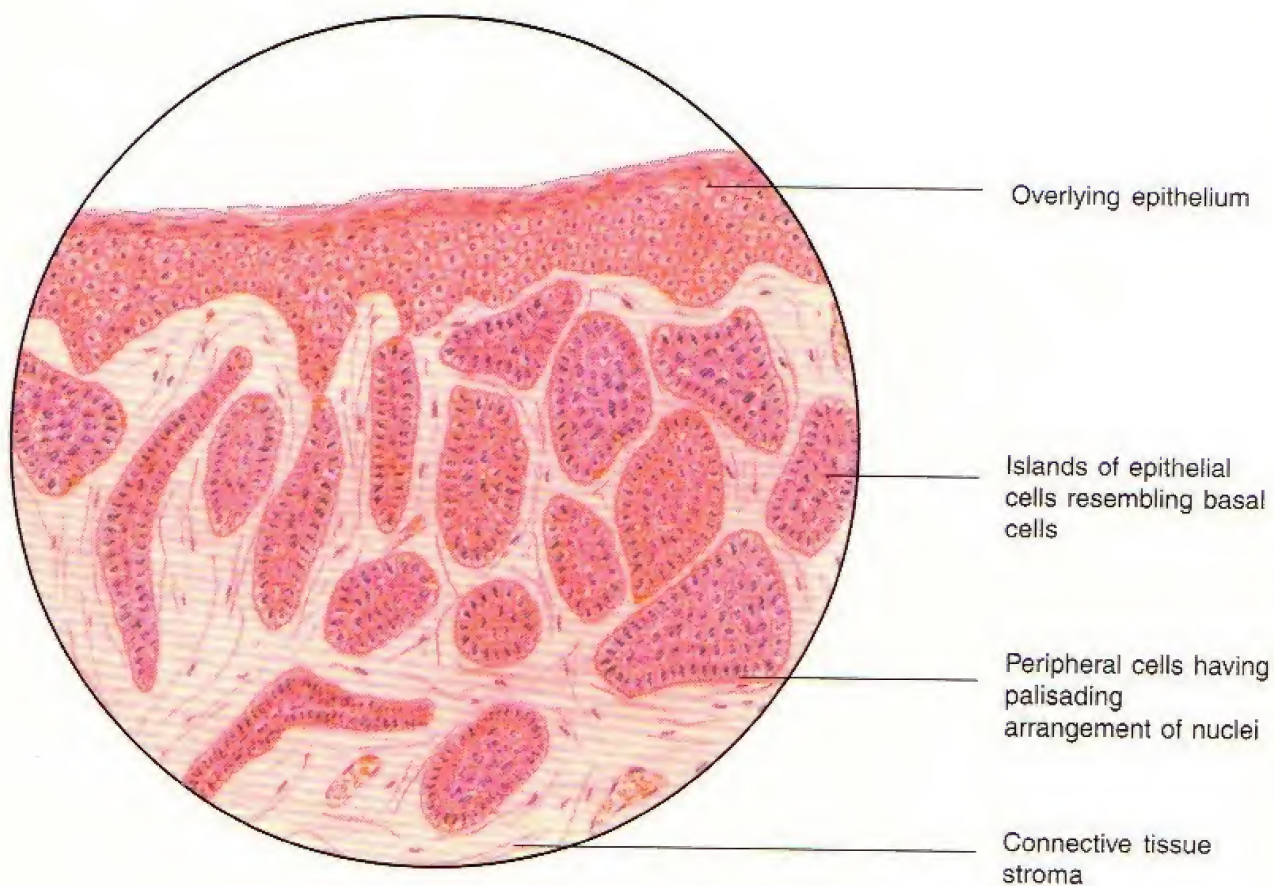


Fig. 20.10 Basal cell carcinoma

sheets, of epithelial cell in the connective tissue. These epithelial cells resemble basal cells with large deeply staining nuclei and variable number of mitotic figures. The peripheral cells of the islands are distinct with palisading arrangement of nucleus.

MALIGNANT MELANOMA

Malignant melanoma is a malignant neoplasm arising from melanocytes. This may develop in a benign melanocytic lesion or from melanocytes of otherwise normal mucosa. Clinically this lesion usually present as deeply pigmented area, sometimes ulcerated and hemorrhagic which tend to increase progressively in size.

Histopathology (Fig. 20.11)

Characteristic feature of malignant melanoma is proliferation of atypical melanocytes. In the initial stage, these cells are seen within the basal layer spreading laterally (radial growth). Atypical melanocytes are larger than normal and show varying degrees of pleomorphism and hyperchromatism. As the lesion progresses further to cause vertical growth phase atypical melanocytes invade into the connective tissue. These cells may be epithelioid or spindle shaped and arranged in the form of loosely aggregated cords or sheets.



Identification Points Fig. No. 20.11

MALIGNANT MELANOMA

- Atypical melanocytes invading connective tissue
- Melanocytes may be epithelioid or spindle shaped with marked pleomorphism
- Melanin pigments may be present

BENIGN CONNECTIVE TISSUE NEOPLASMS

FIBROMA

Fibroma is a benign tumor arising from fibrous connective tissue. Clinically fibroma presents as a painless slow growing, sessile or pedunculated lesion with smooth surface, and firm consistency, pink color, ranging in size from few millimeters to 1 cm.

Histopathology (Fig. 20.12)

The lesional tissue comprises of dense fibrous connective tissue with few fibroblasts and fibrocytes and scanty blood vessels. Collagen fibers are arranged in bundles in a circular, radiating or haphazard fashion. Overlying stratified squamous epithelium is usually atrophic with flat or short rete ridges.



Identification Points Fig. No. 20.12

FIBROMA

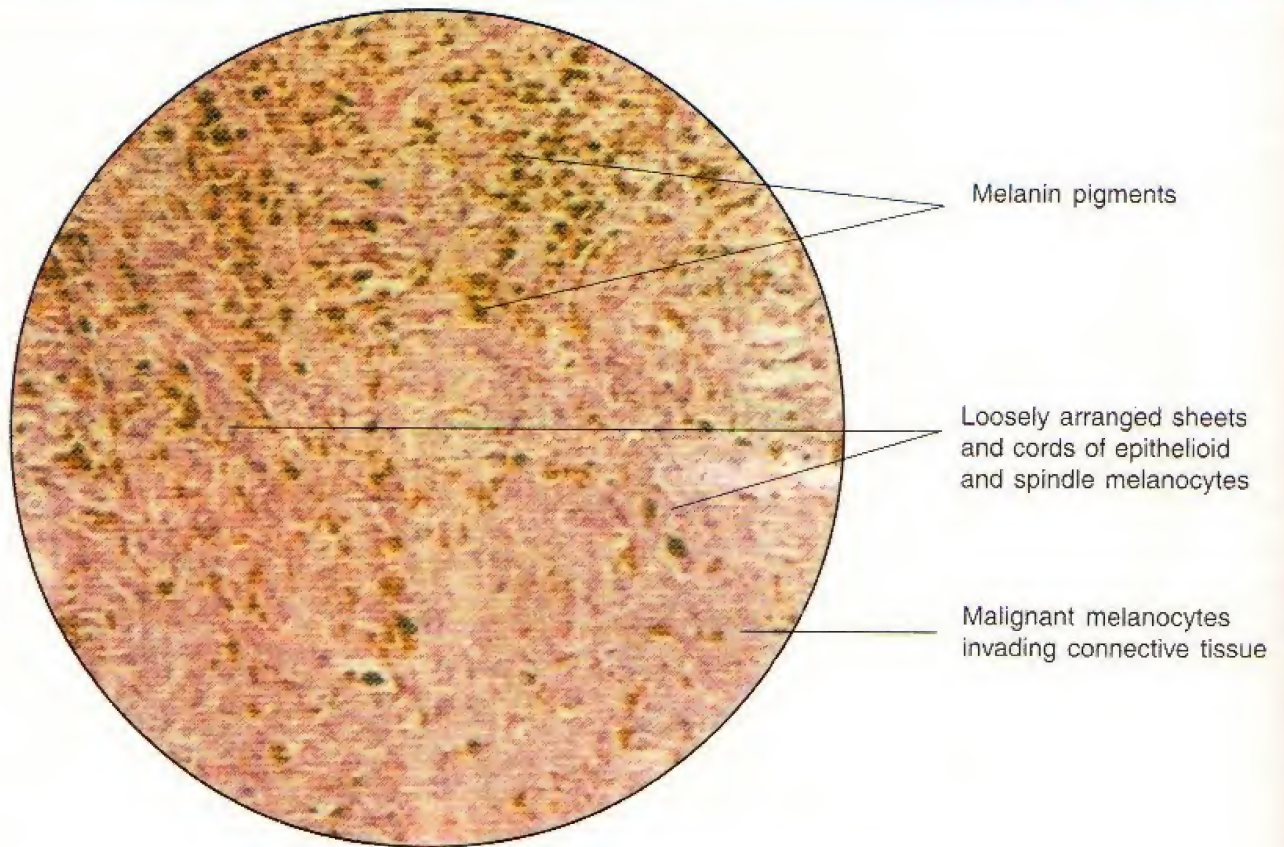
- Dense fibrous connective tissue
- Atrophic epithelium

PERIPHERAL OSSIFYING FIBROMA

This lesion is predominantly a nodular mass of gingiva involving the interdental papilla. Clinically peripheral ossifying fibroma is similar to fibroma; the color may vary from red to pink and frequently with an ulcerated surface.

Histopathology (Fig. 20.13)

Microscopic features are similar to fibroma but associated with formation of mineralized product. Connective tissue is highly cellular specifically in the regions of mineralization.



Malignant melanoma (Photomicrograph 10X)

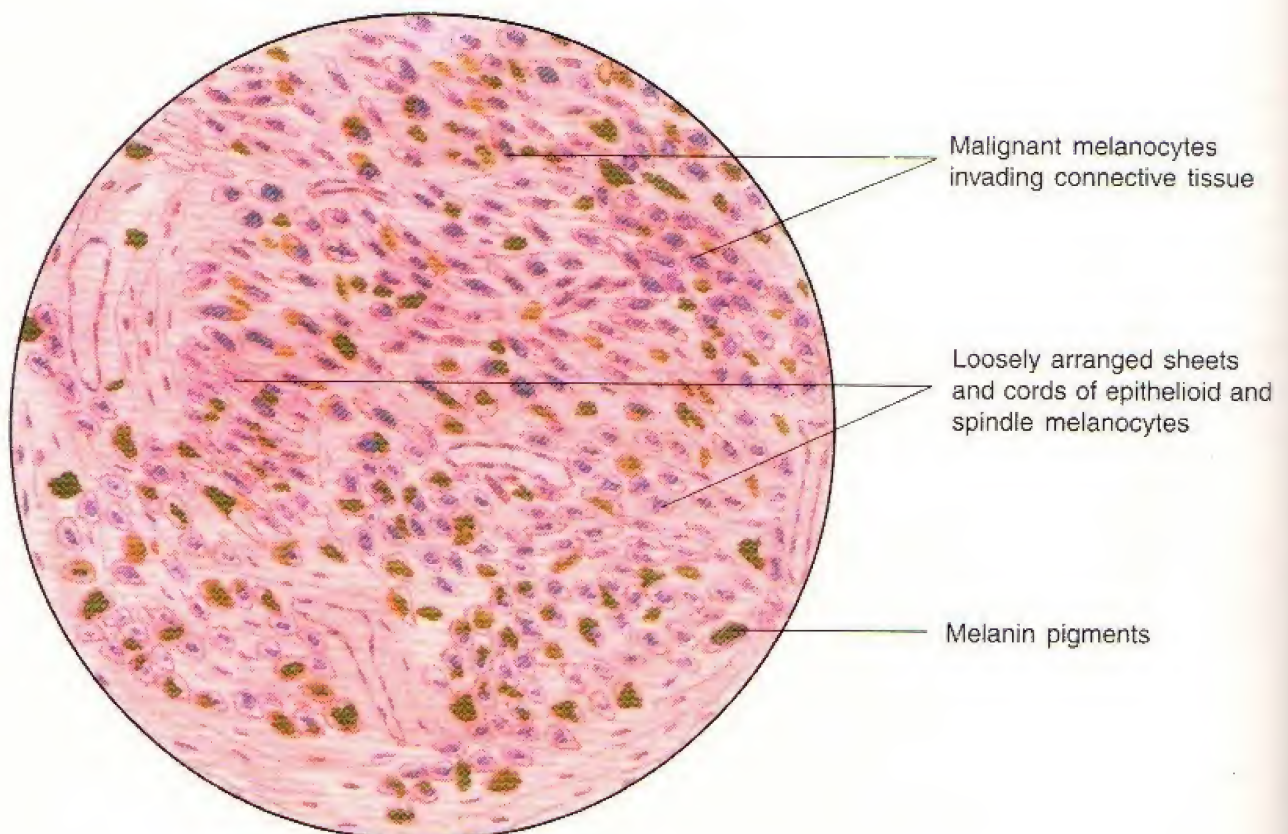
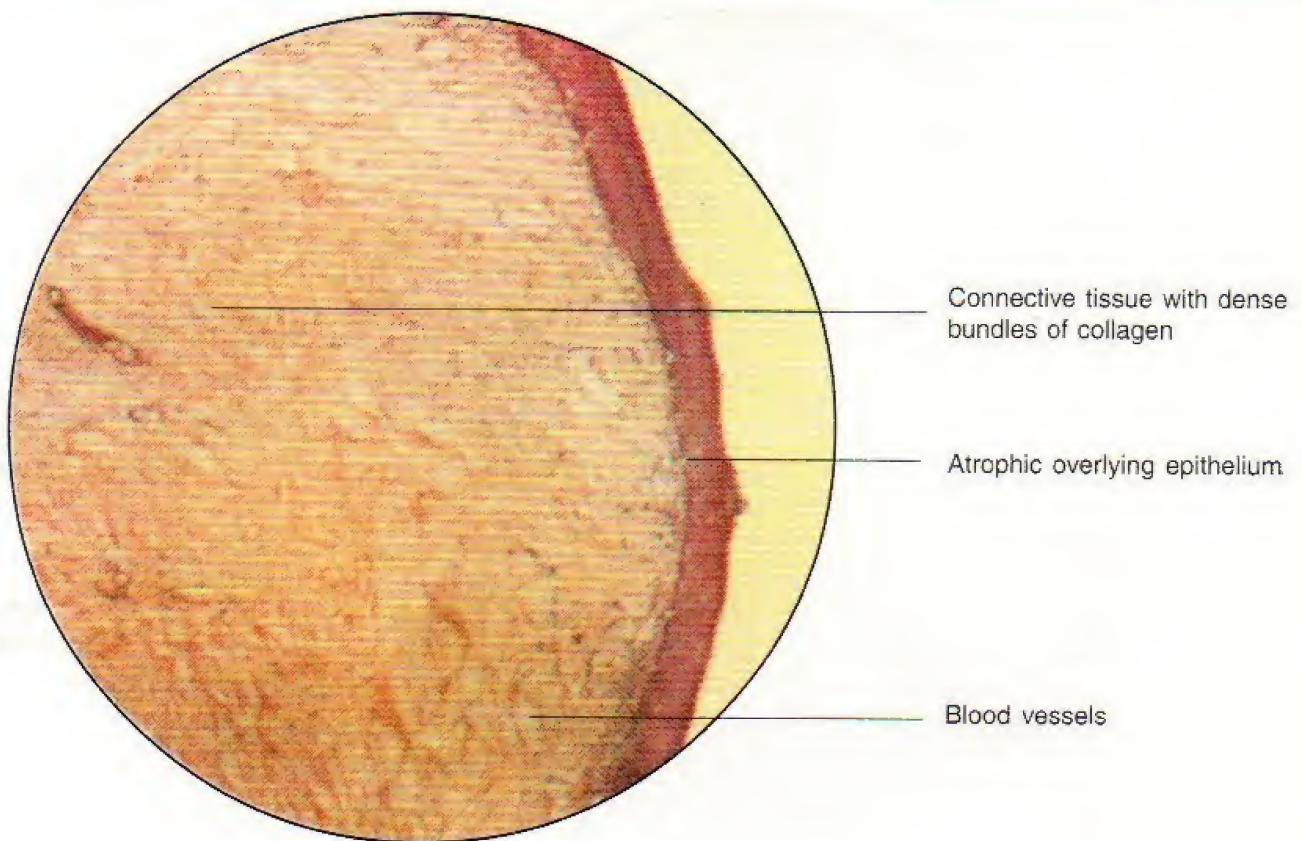


Fig.20.11 Malignant melanoma



Fibroma (Photomicrograph 4X)

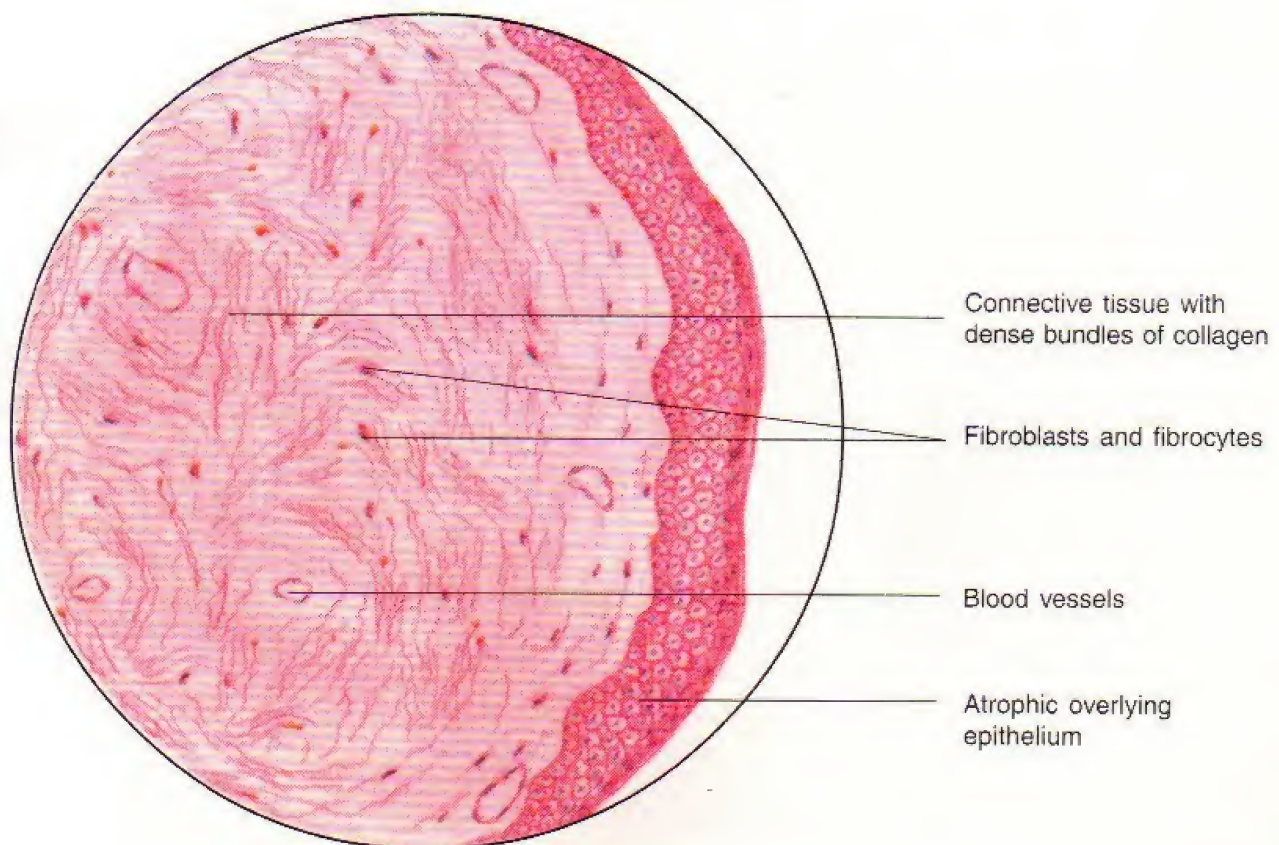
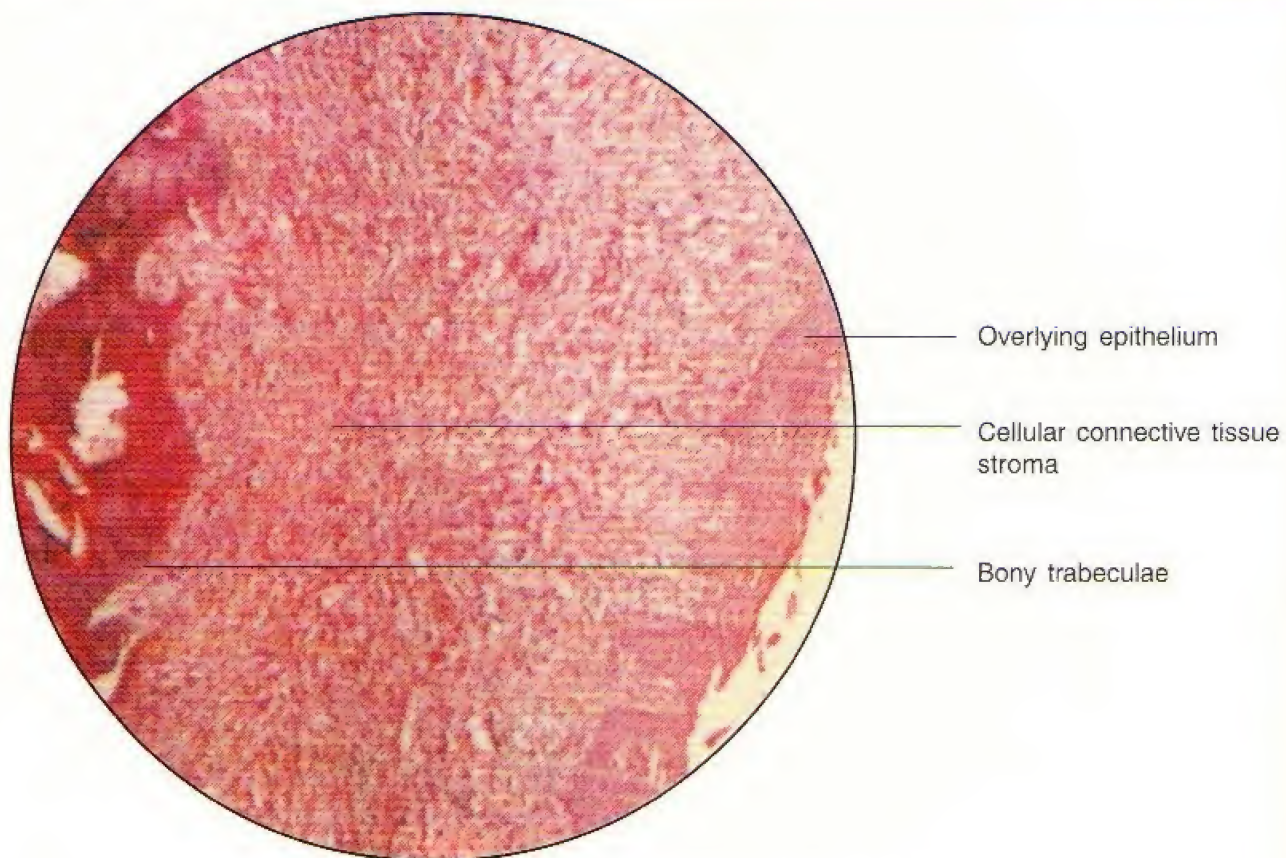


Fig. 20.12 Fibroma



Peripheral ossifying fibroma (Photomicrograph 4X)

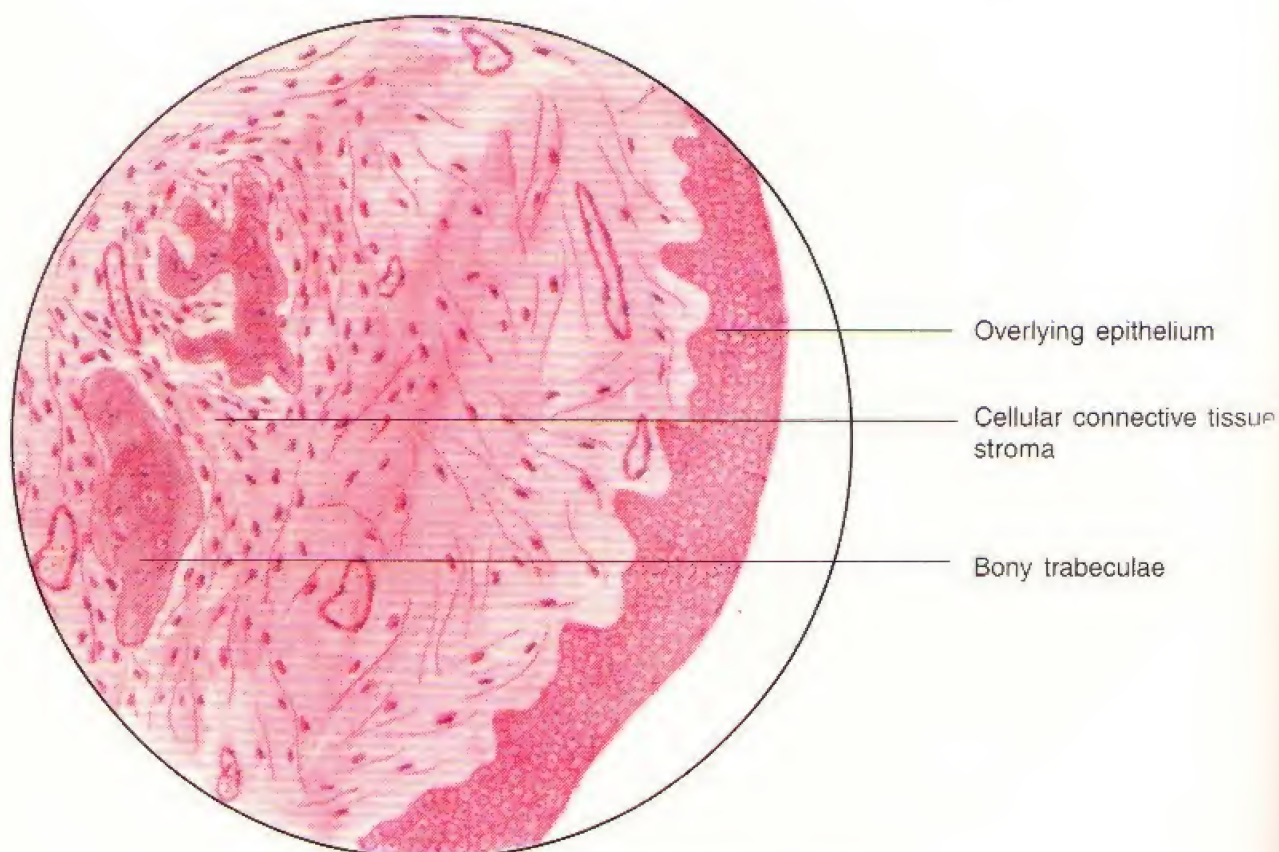


Fig. 20.13 Peripheral ossifying fibroma


Identification Points Fig. No. 20.13
PERIPHERAL OSSIFYING FIBROMA

- Highly cellular connective tissue
- Presence of calcifications

Mineralization may be in the form of osteoid, bony trabeculae or cementum like material. Overlying stratified squamous epithelium may be intact or ulcerated.

LIPOMA

Lipoma is a benign tumor of fat tissue origin and it is present as an asymptomatic, slow growing nodular mass, soft in consistency, with smooth surface, varying in size usually up to 2 to 3 cms. Color of the lesion may be yellowish.

Histopathology (Fig. 20.14)

Lipoma is composed of mature fat cells. Cells are round or ovoid, with empty looking cytoplasm and eccentrically placed nucleus that is pressed against the cell membrane. The lesion is well circumscribed, may have a connective tissue capsule. Connective tissue septa is often seen dividing the lesion into many lobules.

Along with fat cells if fibrous connective tissue is significant it is called fibrolipoma and highly vascular lipoma lesions are called angiolipoma.


Identification Points Fig. No. 20.14
LIPOMA

- Composed of mature fat cells
- Fat cells appears empty with nucleus pushed to periphery
- Presence of connective tissue septa

HEMANGIOMA

Hemangioma is characterized by benign proliferation of blood vessels and is considered as a hamartoma (tumor like malformation native to the site). These lesions usually present as red or purplish, flat or slightly raised lesions.

Histopathology (Fig. 20.15)

The most characteristic histopathological feature of hemangioma is presence of numerous endothelium lined vascular channels containing RBCs. Lesions also show numerous proliferating plump endothelial cells. Based on size of the blood vessels hemangioma can be capillary hemangioma where the vessels are of smaller size or cavernous hemangioma where the vessels are larger.


Identification Points Fig. No. 20.15
HEMANGIOMA

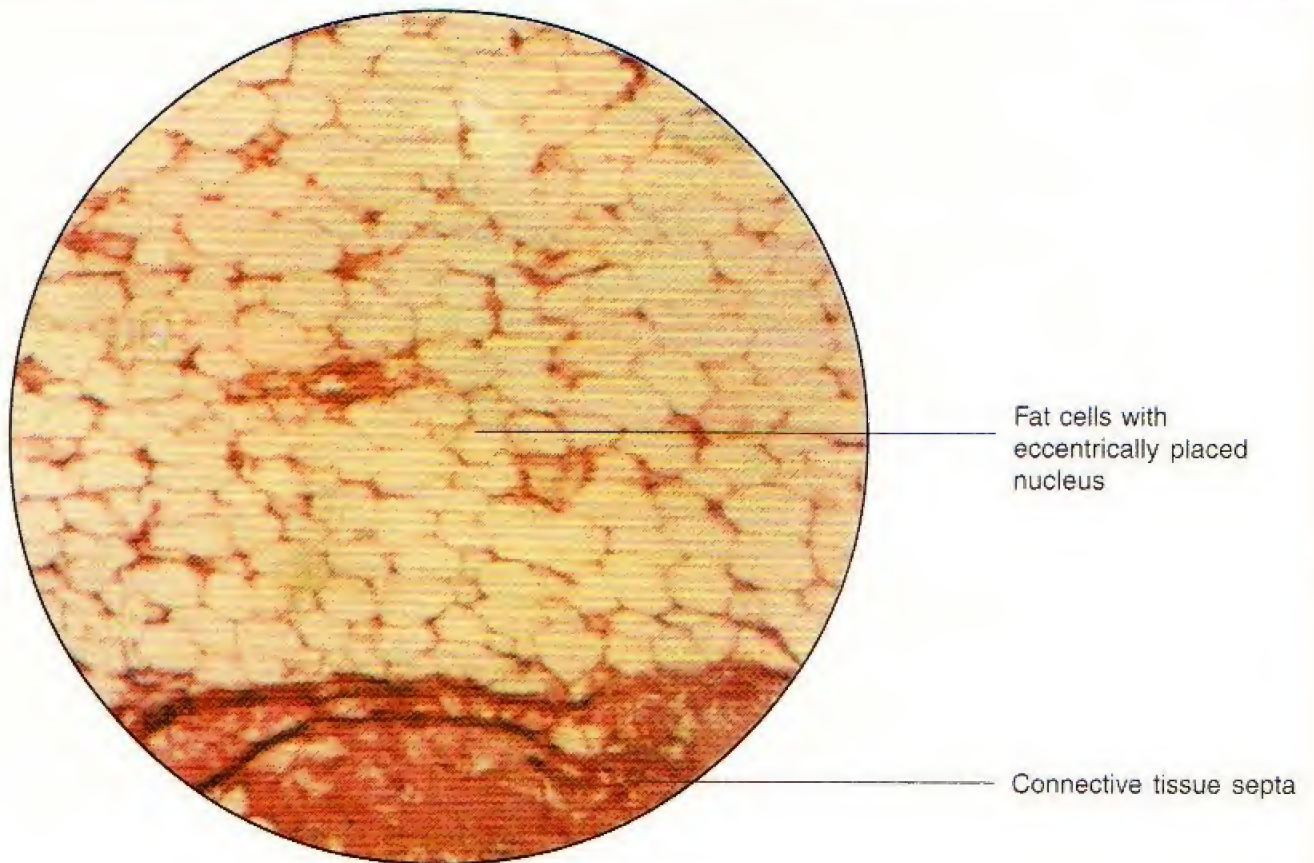
- Multiple blood filled vascular channels
- Proliferating endothelial cells

LYMPHANGIOMA

Lymphangioma is a benign tumor of lymphatic vessels. This is also considered as hamartoma. Oral lymphangioma usually present as a lesion of the tongue that manifest as macroglossia. Tongue lesions show pebbly surface.

Histopathology (Fig. 20.16)

Microscopically lymphangioma shows multiple lymphatic channels lined by endothelial cells and containing proteinaceous fluid and occasional lymphocytes. The lesion is typically located just beneath the epithelium and lymphatic channels replaces the connective tissue papillae.



Lipoma (Photomicrograph 10X)

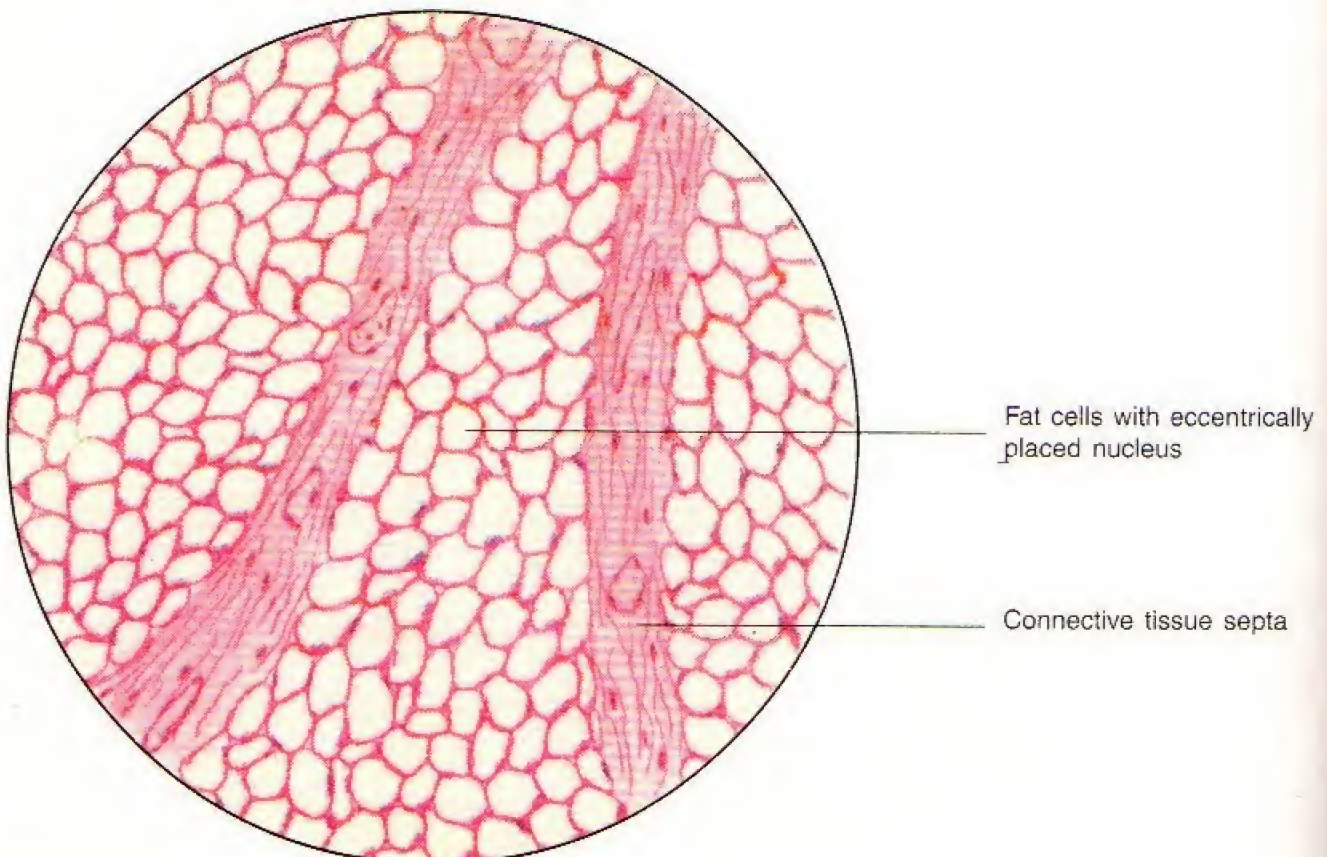
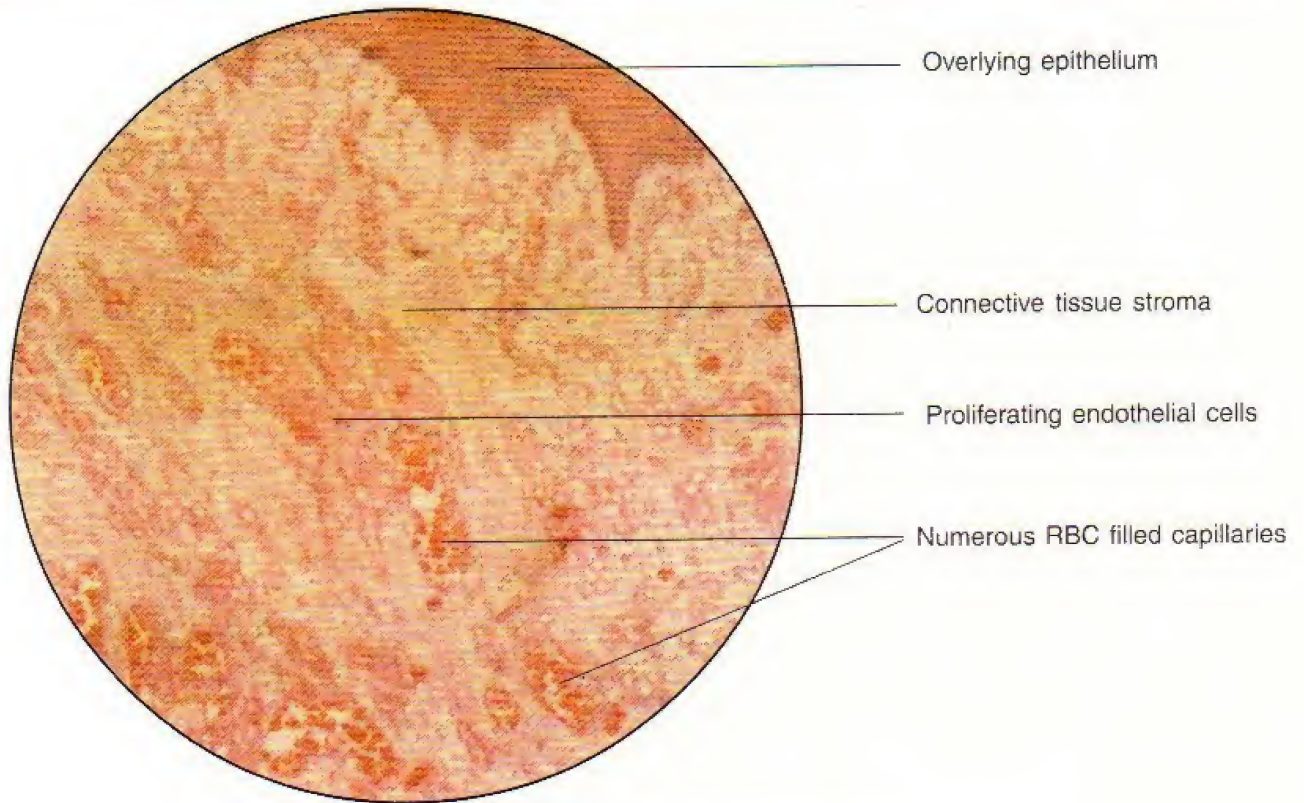


Fig. 20.14 Lipoma



Capillary hemangioma (Photomicrograph 10X)

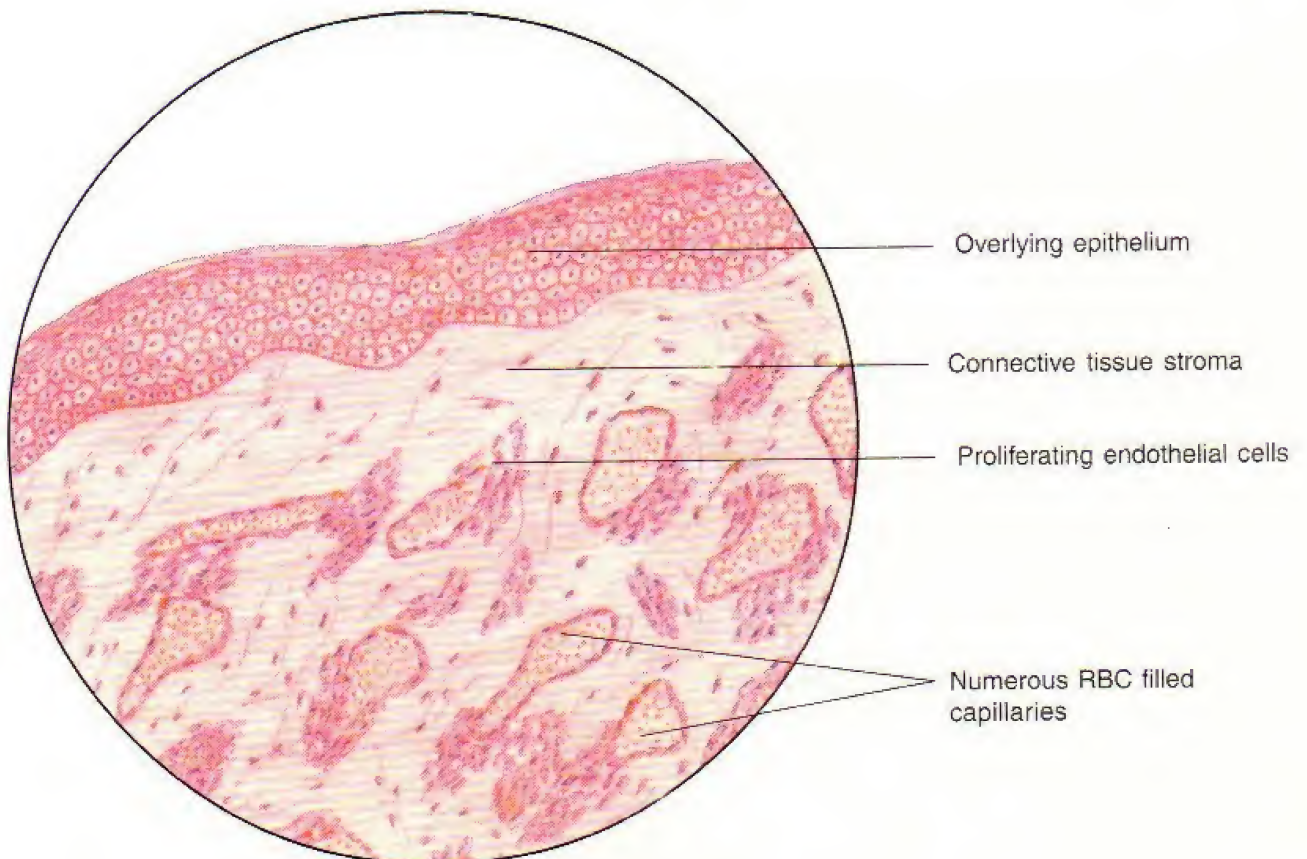


Fig. 20. 15 Capillary hemangioma

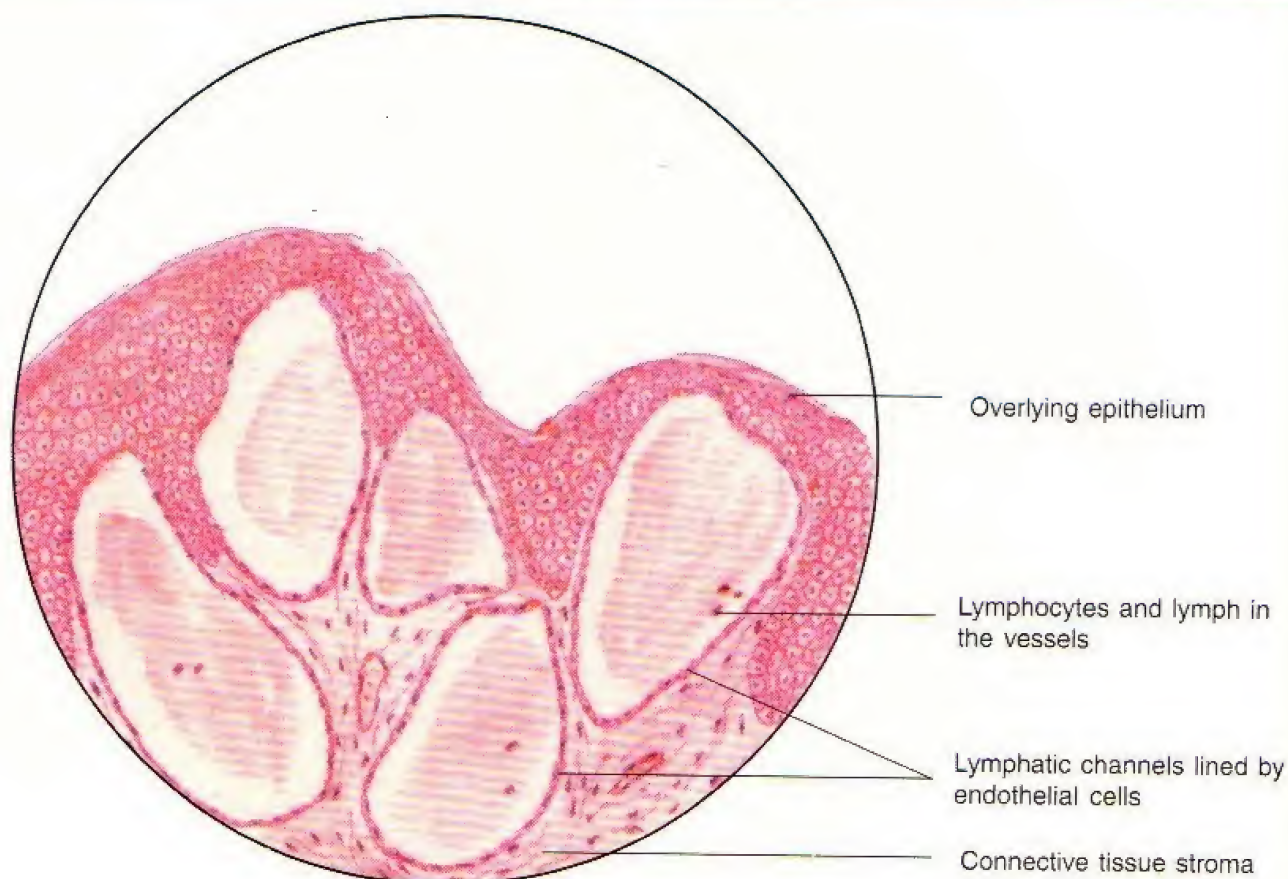


Fig. 20.16 Lymphangioma

**Identification Points Fig. No. 20.16****LYMPHANGIOMA**

- Multiple lymphatic channels containing lymph
- Lymphatic channels replacing the connective tissue papillae

an encapsulated lesion showing two different patterns described as Antoni Type A and Antoni Type B. In Antoni Type A spindle shaped cells have a regular palisading arrangement. These cells may be arranged around a central eosinophilic acellular area called as 'Verocay bodies'. In Antoni type B spindle cells are randomly arranged without palisading

NEURILEMMOMA (SCHWANNOMA)

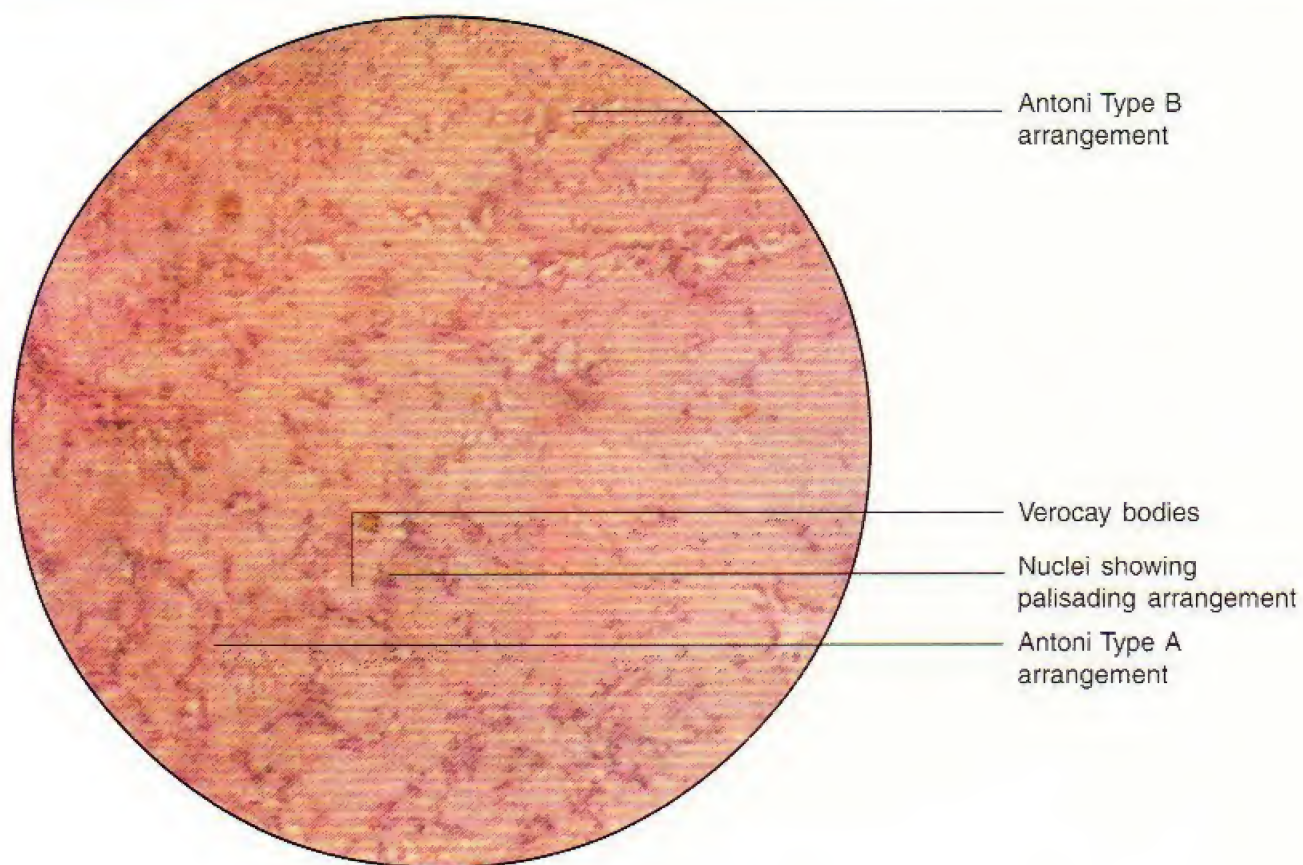
Neurilemmoma is a benign tumor of nerve tissue, originating from the Schwann cells. Clinically this lesion presents as an asymptomatic slow growing nodular swelling in association with a nerve trunk, pushing the nerve aside.

Histopathology (Fig. 20.17)

Microscopically neurilemmoma present as a as

**Identification Points Fig. No. 20.17****NEURILEMMOMA**

- Two patterns; Antoni type A and Antoni type B
- Antoni type A with palisading arrangement of cells enclosing 'Verocay bodies'
- Antoni type B with disorderly arrangement of cells.



Neurilemmoma (Photomicrograph 10X)

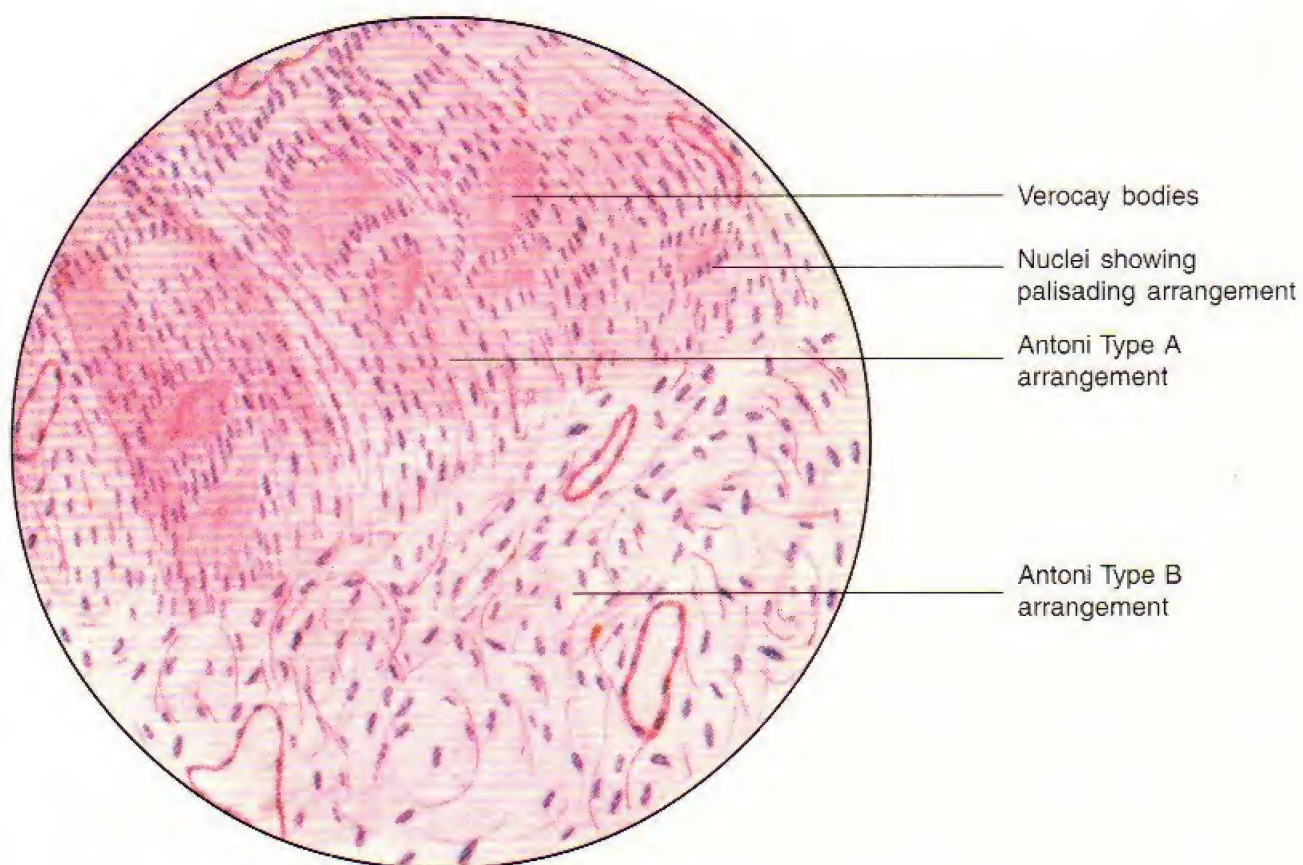
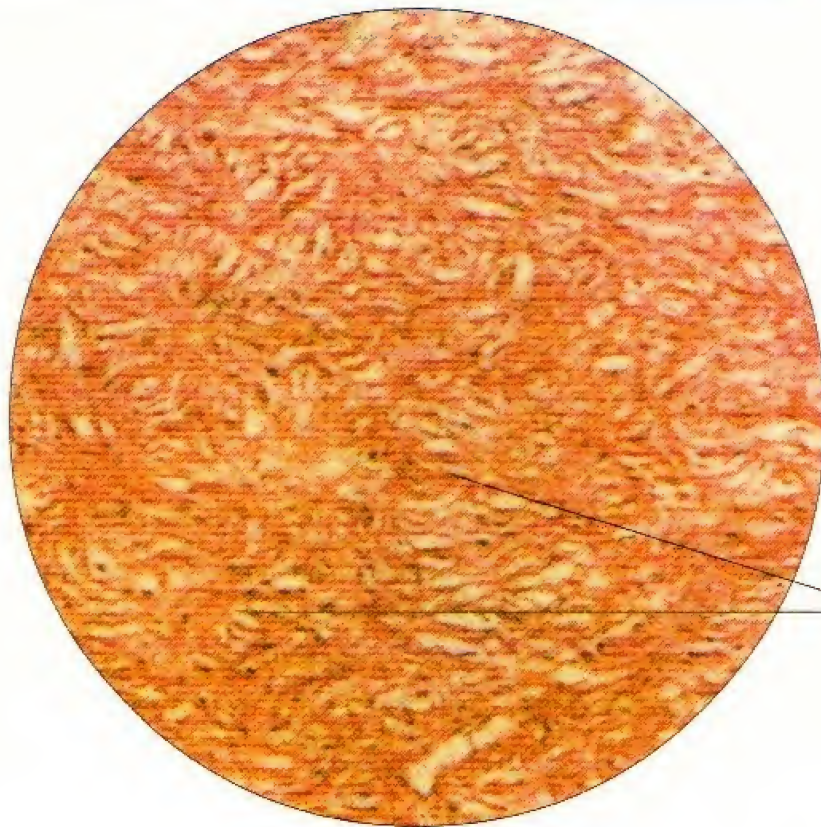
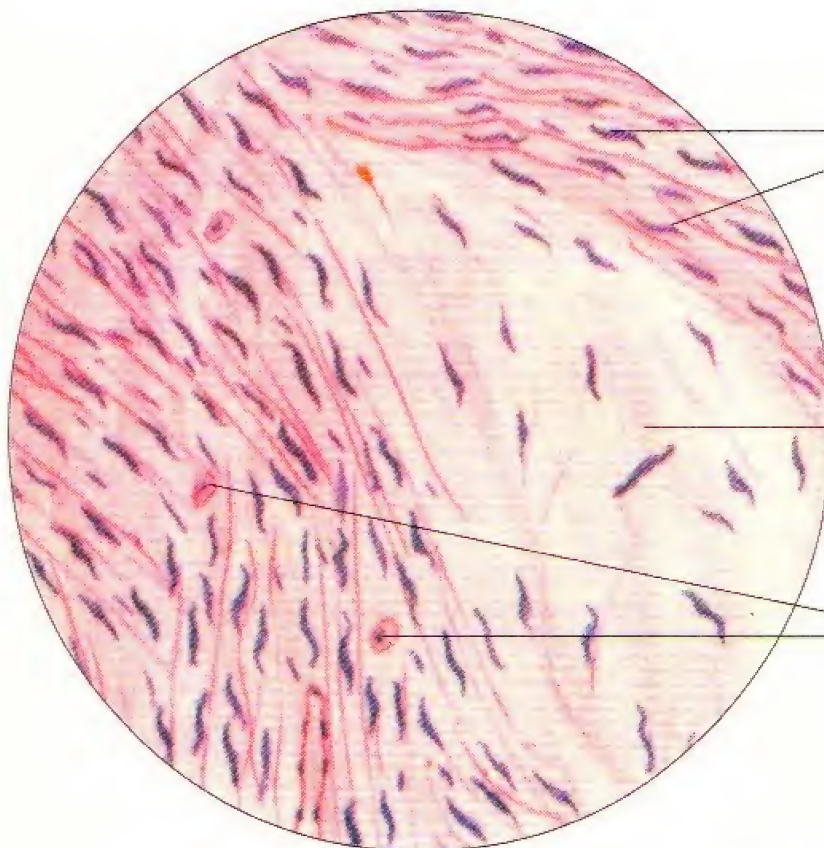


Fig. 20.17 Neurilemmoma



Spindle shaped cells with wavy nucleus

Neurofibroma (Photograph 10X)



Spindle shaped cells with wavy nucleus

Areas of myxoid degeneration

Mast cells

Fig. 20.18 Neurofibroma

arrangement. Tissue is less cellular and cells are arranged in a disorderly manner in a loose myxomatous stroma.

NEUROFIBROMA

Neurofibroma is a benign tumor of nerve tissue arising from Schwann cells and perineural fibroblasts. Solitary neurofibroma is seen as a slow growing soft painless nodular mass. Multiple neurofibromas are seen in neurofibromatosis.

Histopathology (Fig. 20.18)

Tumor is composed of interlacing bundles of delicate collagen fibers with spindle shaped cells having wavy nucleus and fibroblasts. The lesion



Identification Points Fig. No. 20.18

NEUROFIBROMA

- Proliferating spindle shaped cells having wavy nuclei
- Presence of numerous mast cells.

may show myxomatous areas and numerous mast cells.

MALIGNANT CONNECTIVE TISSUE TUMORS

FIBROSARCOMA

Fibrosarcoma is a malignant neoplasm of fibroblasts. This lesion clinically present as a

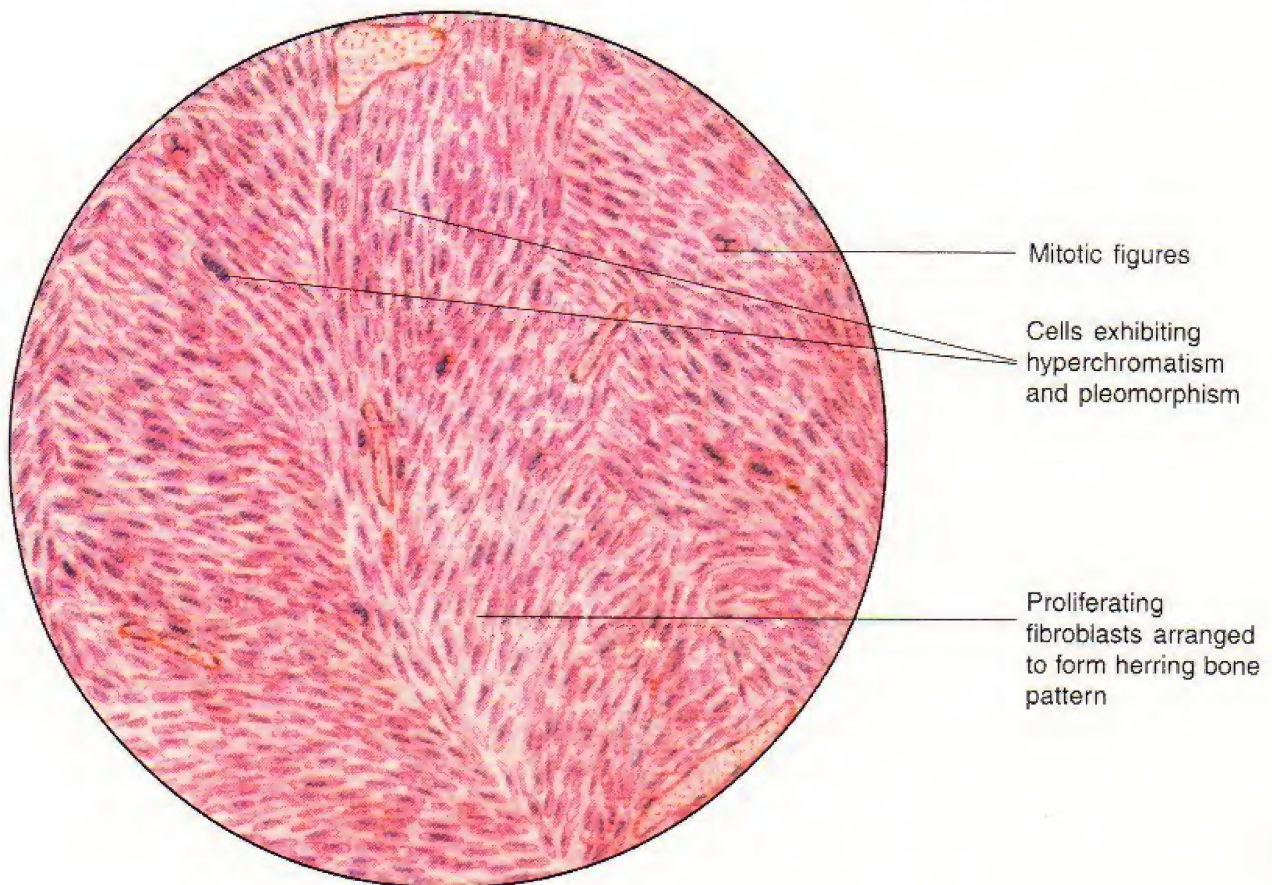


Fig. 20.19 Fibrosarcoma

slow or sometimes rapidly growing mass invading the local tissue.

Histopathology (Fig. 20.19)

Fibrosarcoma is characterized by proliferation of fibroblasts, showing varying degrees of atypical changes. In well differentiated lesions fibroblasts are spindle shaped and arranged to form fascicles that form a 'herring bone pattern'. The cells are less organized and show considerable pleomorphism in poorly differentiated lesions. Variable number of mitotic figures can be identified. The amount of collagen produced is lesser in poorly differentiated tumors than in well differentiated tumors.



Identification Points Fig. No. 20.19

FIBROSARCOMA

- Proliferating atypical fibroblasts
- Cells and fibers arranged to form 'herring bone pattern'
- Presence of mitotic figures

OSTEOSARCOMA

Osteosarcoma is a malignant neoplasm of the bone. Early clinical manifestations of this disease are pain and swelling. When jaw bones are involved, loosening of teeth and paresthesia may be noted. Characteristic radiographic presentation is 'sun-ray' or 'sunburst' appearance.

Histopathology (Fig. 20.20)

The characteristic microscopic feature is proliferation of atypical osteoblasts. These cells are arranged in a disorderly fashion about trabeculae of bone and show considerable pleomorphism and hyperchromatism. Areas of



Identification Points Fig. No. 20.20

OSTEOSARCOMA

- Proliferating atypical osteoblasts
- Formation of tumor osteoid
- Histological variants are - osteoblastic, chondroblastic and fibroblastic osteosarcomas.

tumor osteoid deposited by these osteoblasts can be seen. Histological variants are osteoblastic, fibroblastic, and chondroblastic osteosarcomas.

TUMOR LIKE LESIONS

CENTRAL GIANT CELL GRANULOMA

This is a destructive lesion of the jaw bones initially asymptomatic, slowly causing bony expansion and facial asymmetry. Radiographic presentation is in the form of unilocular or more frequently as multilocular radiolucency.

Histopathology (Fig. 20.21)

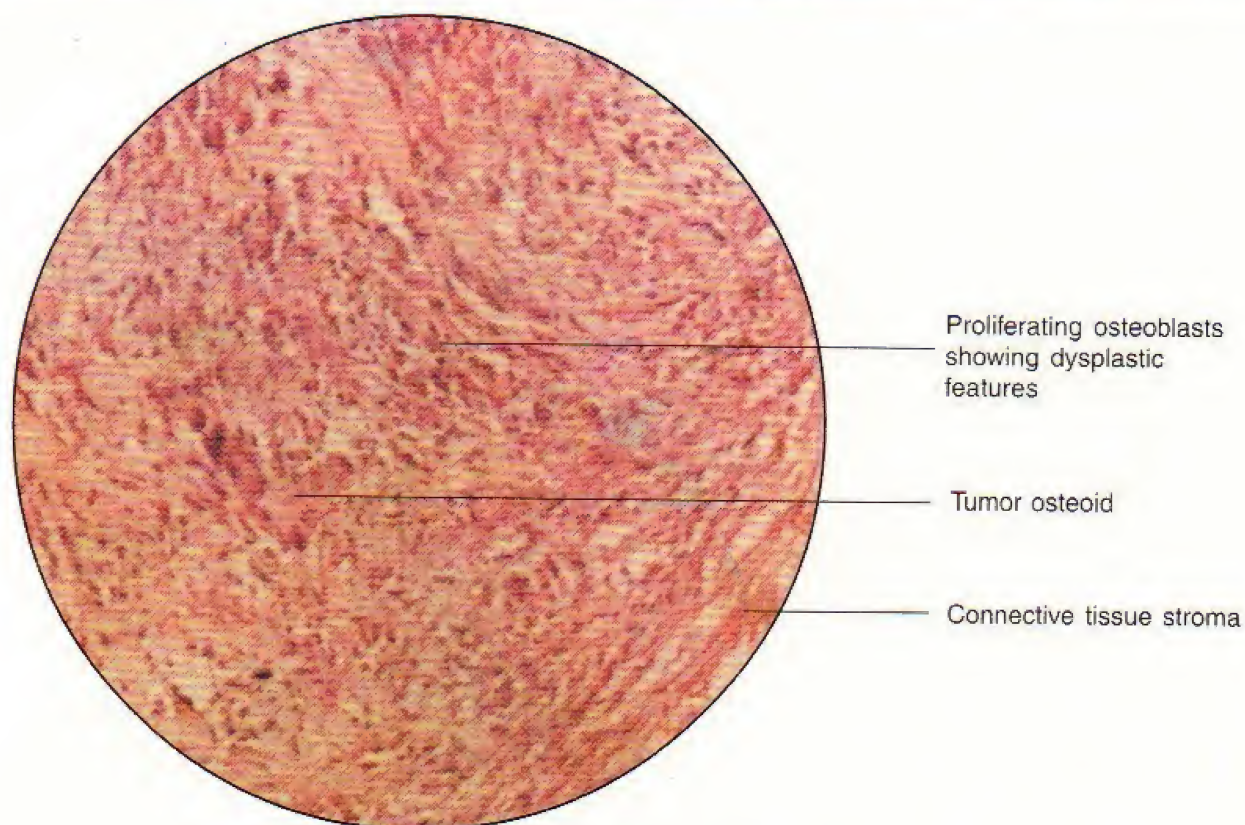
Lesional tissue is composed of highly cellular connective tissue stroma with numerous spindle shaped cells. Multinucleated giant cells are distributed in this connective tissue. Giant cells are large cells with many nuclei up to 20 or more. Giant cells are usually aggregated close to the blood vessels.



Identification Points Fig. No. 20.21

CENTRAL GIANT CELL GRANULOMA

- Highly cellular connective tissue stroma
- Presence of multiple giant cells
- Giant cells arranged close to blood vessels



Osteosarcoma (Photomicrograph 10X)

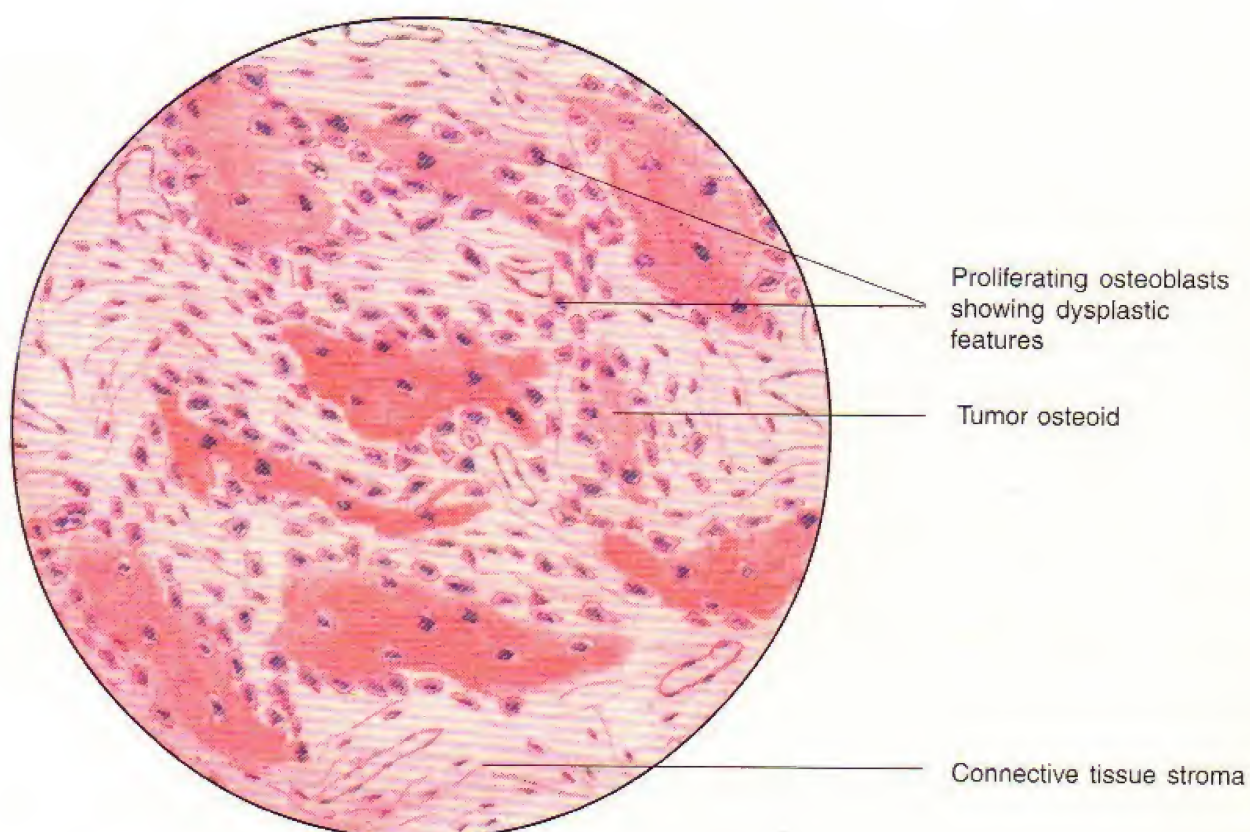
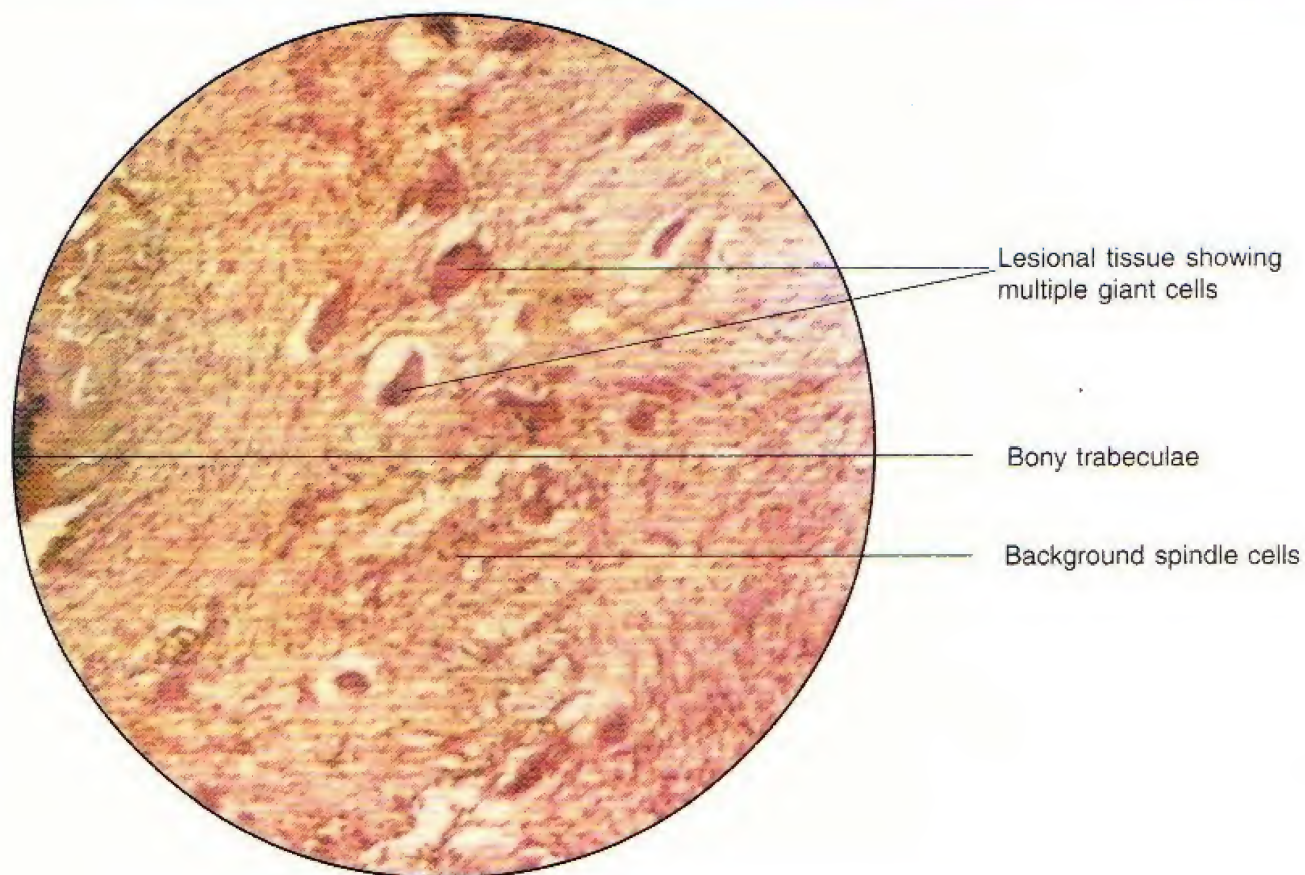


Fig.20.20 Osteosarcoma



Central giant cell granuloma (Photomicrograph 10X)

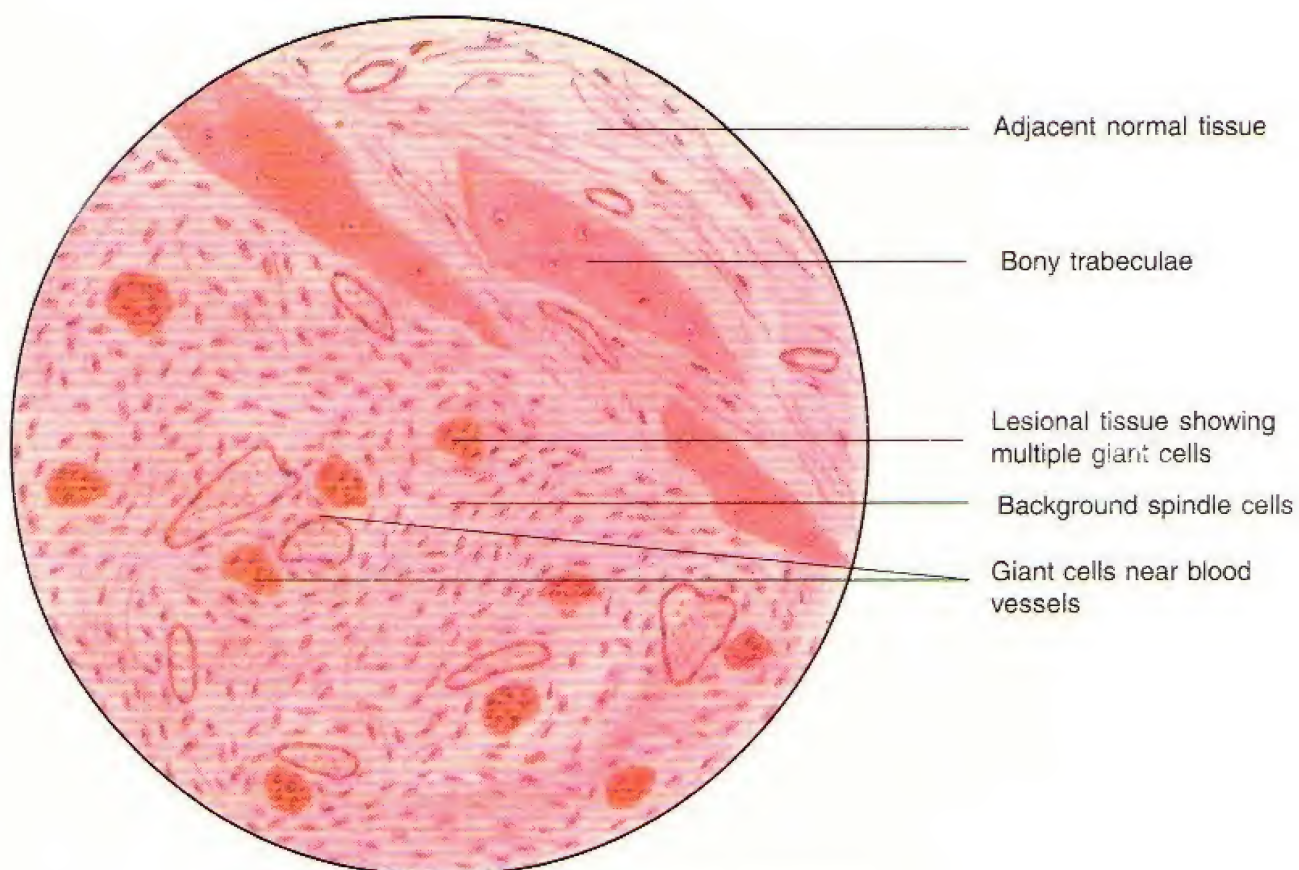


Fig.20.21 Central giant cell granuloma

PERIPHERAL GIANT CELL GRANULOMA

This lesion is a tumor like growth that occur predominantly in the gingiva presents as a red or reddish blue nodular mass. Clinically these lesions resemble pyogenic granuloma.

Histopathology (Fig. 20.22)

Lesional tissue is composed of many multinucleated giant cells distributed in a highly cellular connective tissue having numerous spindle shaped cells.

Giant cells are large round or irregular cells with few or many nuclei. Many blood vessels and extravasated RBCs are seen. One of the characteristic feature of this lesion is a zone of dense fibrous connective tissue separating the lesional tissue from overlying stratified squamous epithelium.



Identification Points Fig. No. 20.22

PERIPHERAL GIANT CELL GRANULOMA

- Highly cellular connective tissue stroma
- Presence of multiple giant cells
- Zone of connective tissue separating lesional tissue from epithelium

PYOGENIC GRANULOMA

Pyogenic granuloma is a common tumor like lesion usually occurring on gingiva. These lesions present as sessile or pedunculated mass with a smooth or lobulated surface, soft in consistency, red or pinkish in color ranging in size from few mms to cms.

Histopathology (Fig. 20.23)

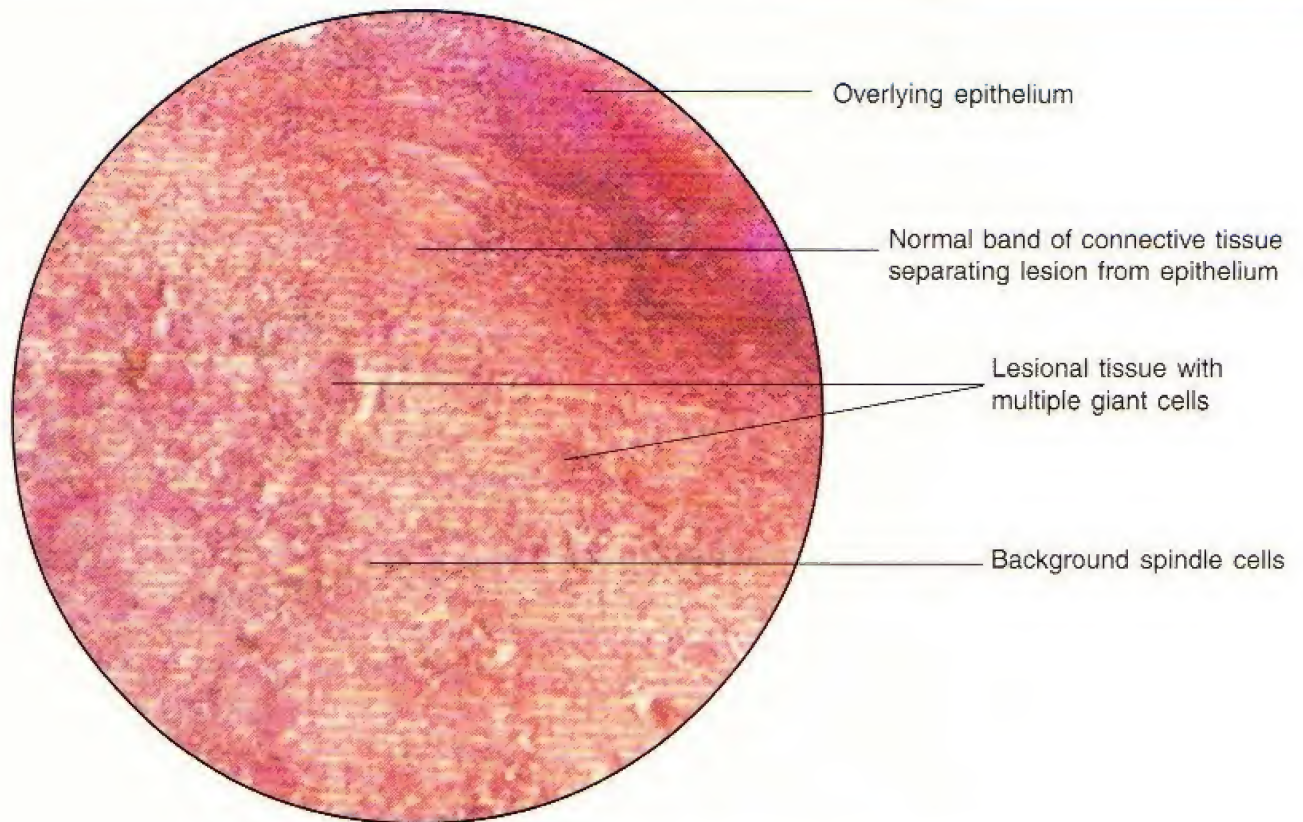
Microscopically pyogenic granuloma resembles granulation tissue. The lesion is composed of proliferating fibroblasts, endothelial cells and budding capillaries. Numerous endothelium lined vascular channels filled with RBCs are seen. Lesional tissue is densely infiltrated with chronic inflammatory cells predominantly plasma cells and lymphocytes. Overlying epithelium is usually ulcerated and this ulcerated region is covered with a fibrinous exudates densely infiltrated with acute and chronic inflammatory cells.



Identification Points Fig. No. 20.23

PYOGENIC GRANULOMA

- Granulation tissue containing proliferating fibroblasts, endothelial cells and inflammatory cells
- Ulcerated overlying epithelium



Peripheral giant cell granuloma (Photomicrograph 10X)

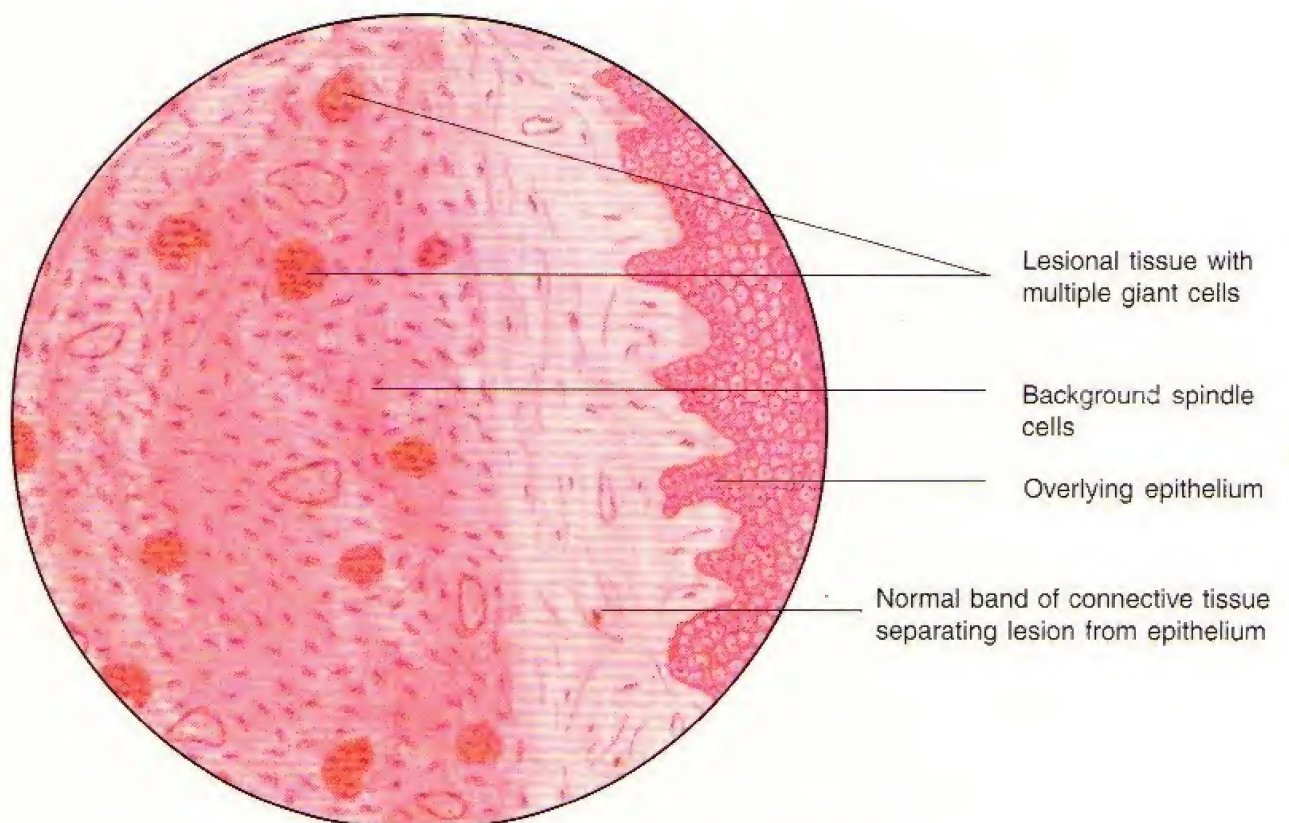
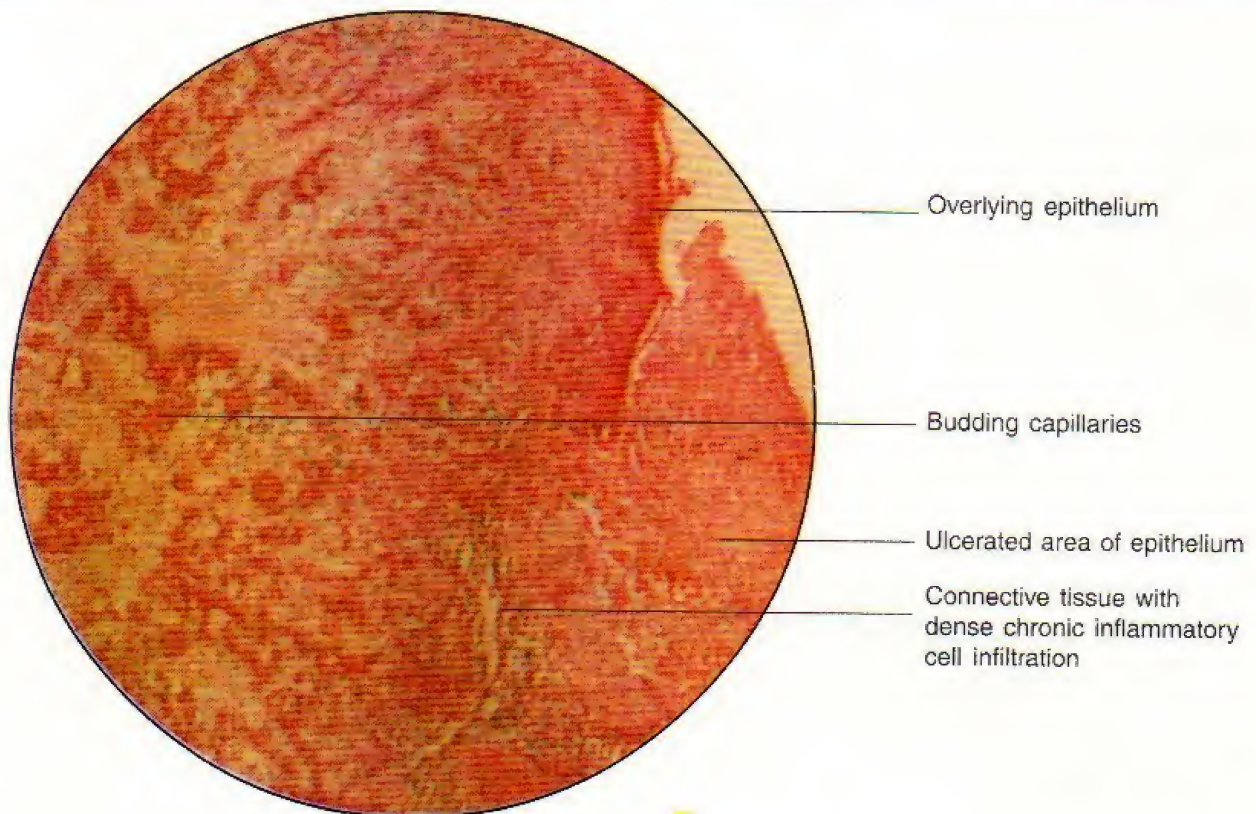


Fig.20.22 Peripheral giant cell granuloma



Pyogenic granuloma (Photomicrograph 10X)

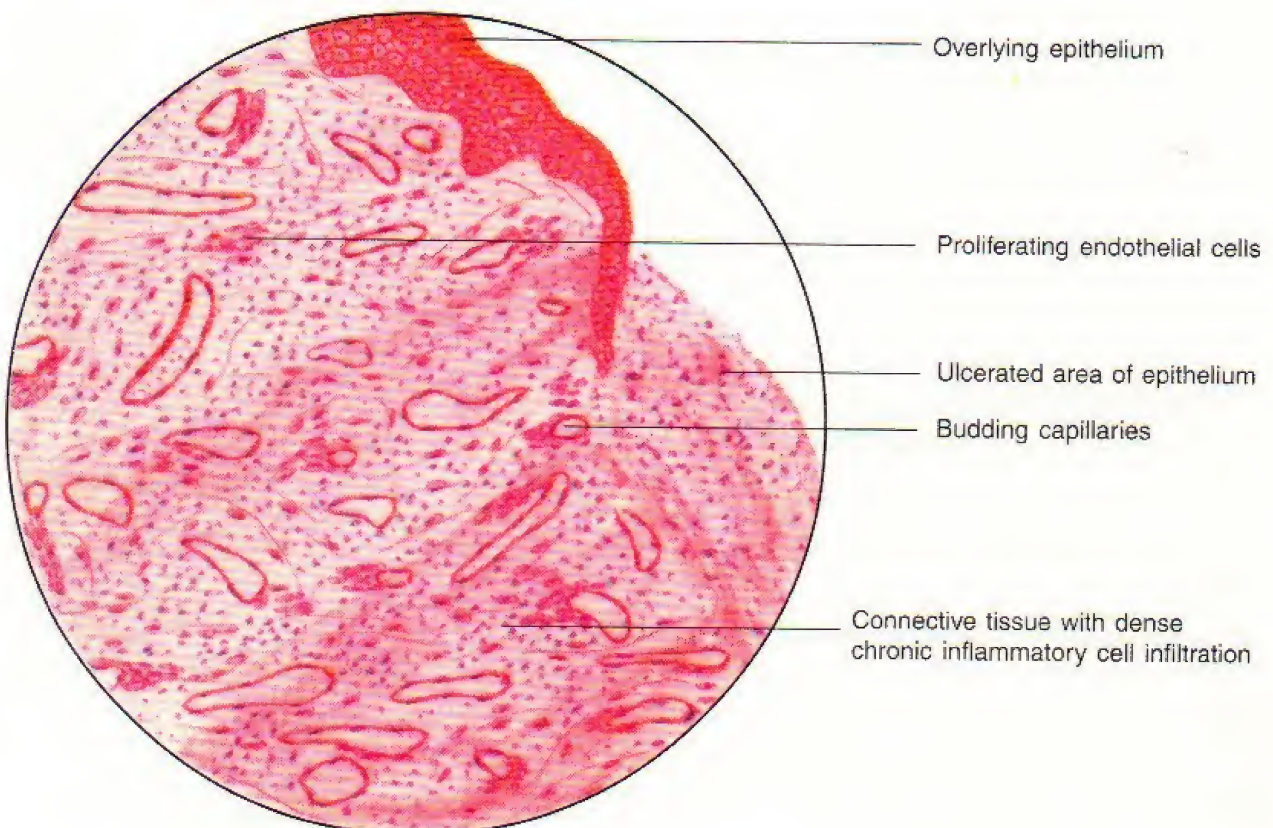


Fig.20.23 Pyogenic granuloma

21

Developmental Disturbances

- Fordyce's spots or Fordyce's granules
- Developmental disturbances affecting the teeth
 - Gemination
 - Twinning
 - Fusion
 - Concrescence
 - Dilaceration
 - Talon cusp
 - Taurodontism
 - Dens evaginatus
 - Dens invaginatus
 - Supernumerary teeth or hyperdontia
 - Anodontia or hypodontia
 - Supernumerary cusp and roots
 - Enameloma
 - Micro and macrodontia

FORDYCE'S SPOTS OR FORDYCE'S GRANULES

Fordyce's granules are the developmental anomaly affecting the oral mucosa, which clinically appear as yellowish white papular lesions. They are characterized by heterotopic collection of sebaceous glands in the oral mucosa and considered as normal anatomic variation.

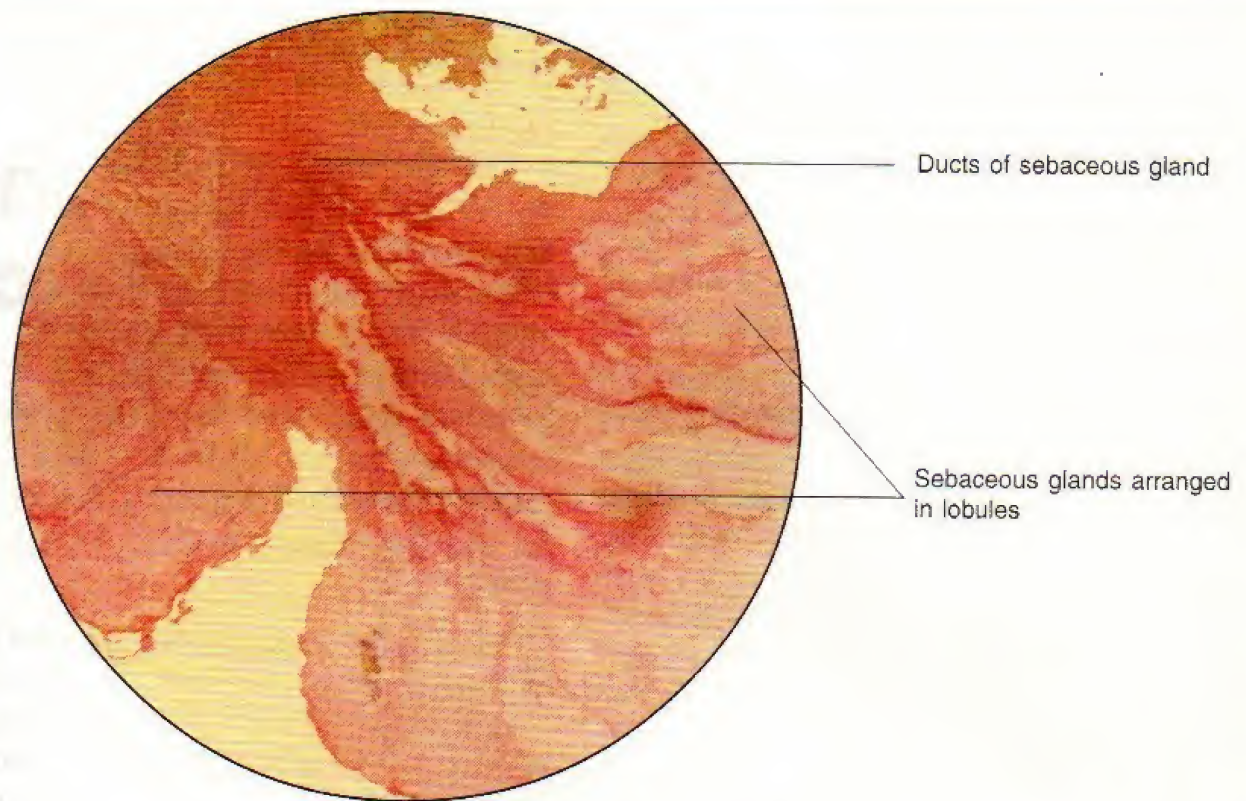
Histopathology (Fig. 21.1)

Fordyce's granules are characterized by the presence of lobules of sebaceous cells beneath the epithelium, often with a central duct communicating to the surface. The sebaceous cells are polygonal with centrally located nucleus and abundant foamy cytoplasm. In contrast to the sebaceous glands of the skin Fordyce's granules lack hair follicle.

DEVELOPMENTAL DISTURBANCES AFFECTING THE TEETH

GEMINATION

This is a developmental anomaly affecting shape of tooth in which a single tooth germ is attempting to divide, by an invagination, resulting in incomplete formation of two teeth. So the affected tooth has a bifid crown (completely or incompletely separated crown) with a single root. In mild cases only a deep groove is seen extending from incisal edge to the cervical portion. Clinically there is no change in the number of teeth in the oral cavity.



Fordyce's Granules (Photomicrograph 4X)

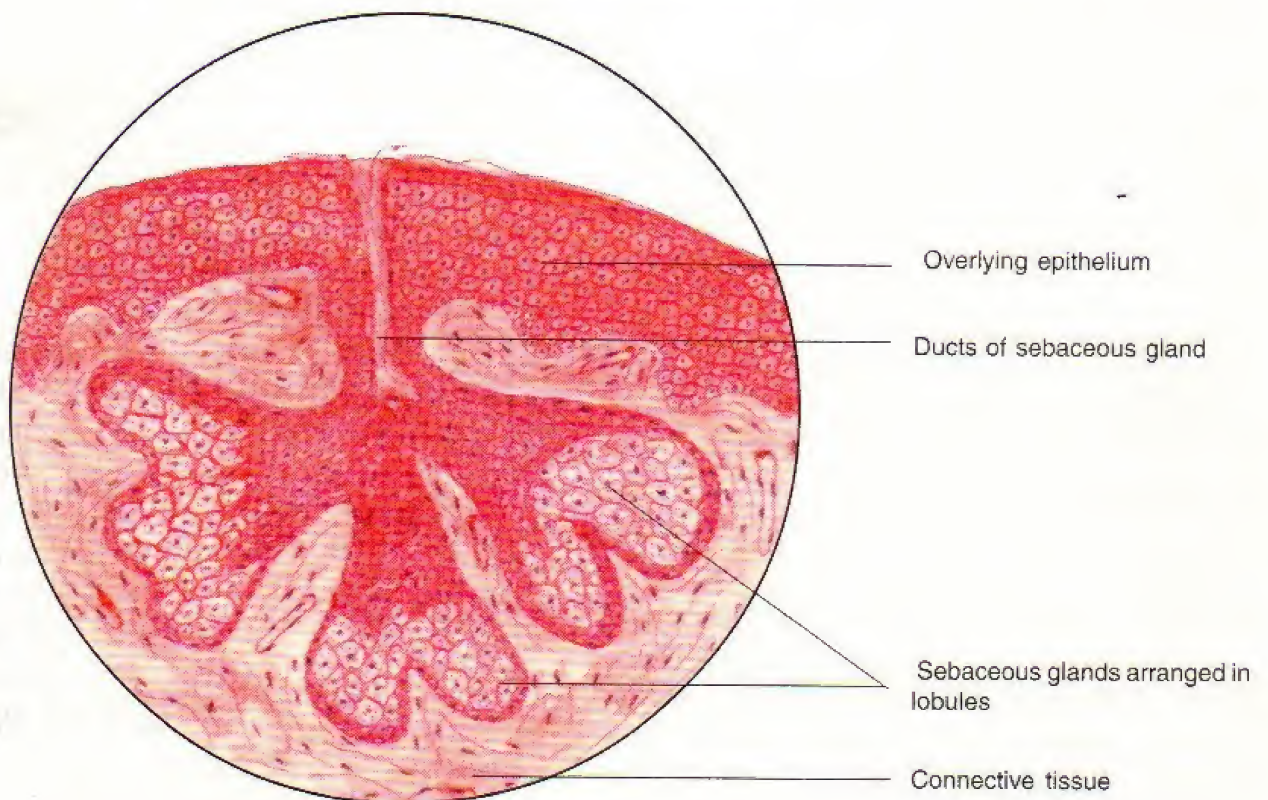


Fig. 21.1 Fordyce's Granules

TWINNING

If the invagination leads to complete division of tooth into two, that result in formation of two smaller teeth which are identical in appearance. Clinically there is an increase in number of teeth in dental arch.

FUSION (Fig. 21.2)

In this anomaly two normally separated tooth germs fuse (join) together to form a single tooth. Depending on time of fusion the resulting tooth may be a completely fused tooth with single crown and root or separated crown with single root. In case of fusion the number of teeth in dental arch is less with a large tooth. This fusion results from a physical force or pressure resulting in contact between two developing tooth germs. One characteristic feature of true fusion is that dentin is always confluent (fusion at dentin level).

CONCRESCENCE (Fig. 21.3)

When fusion of two teeth occurs by the deposition of cementum it is called concrescence. This fusion occurs after the complete formation of root. This can also occur due to traumatic injury, crowding with resorption of inter dental bone so that roots of the adjacent teeth are approximated. This particular condition can cause complications at the time of extraction resulting in fracture of bone etc.

DILACERATION (Fig. 21.4)

Any sharp bend or curve in the root or crown of the tooth is called dilaceration. This occurs due to trauma to the developing tooth resulting in change in the position of already formed portion of the tooth and the remaining part of the tooth form at a different angle. The bend can occur at any region of tooth depending on the amount of tooth formed before injury. Clinical significance

of this condition can be difficulty in extraction of affected tooth.

TALON CUSP

This is an anomalous cusp like structure projecting from the lingual aspect, in the region of cingulum of maxillary and mandibular incisors. This resembles eagle's talon, hence called talon cusp. This structure has an enamel cover with dentin and a central core of pulp. This is separated from the tooth by a groove. Talon cusp may cause interference in occlusion or make the tooth more prone to caries because of the groove.

Talon cusp is a common feature in Rubinstein - Taybi Syndrome.

TAURODONTISM (Fig. 21.5)

Taurodontism is a developmental anomaly affecting the shape of the tooth in which body of the tooth is enlarged at the expense of root. This condition arises due to failure of Hertwig's epithelial root sheath to invaginate at the proper horizontal level.

The affected tooth appears rectangular without cervical constriction and the bifurcation of the root is shifted more apical than normal. The name taurodontism is given because the tooth appears like a bull's tooth (similar to the tooth of cud-chewing animals). In the radiograph pulp chamber appears to be extremely enlarged with increased apico-occlusal height. Based on the level of bifurcation these affected tooth can be

- hypotaurodont – Bifurcation is slightly apical to normal.
- Mesotaurodont – Bifurcation in the middle of root.
- Hypertaurodont – Bifurcation at the apical 1/3 or no bifurcation at all.

Dens evaginatus (Leong's premolar)

Dens evaginatus is a developmental anomaly characterized by the presence of a globule of enamel or an extra cusp on the occlusal aspect between the buccal and lingual cusps of premolars. This condition develop due to evagination of inner enamel epithelium and dental papilla in to the enamel organ. This extra cusp may interfere with occlusion and may cause pulp exposure following attrition.

Dens invaginatus (Dens in dente)

This is a developmental anomaly affecting the shape of the tooth which occur due to invagination of enamel organ into the dental papilla during odontogenesis. The affected tooth shows an invagination that varies from slightly accentuated lingual pit to a deep folding reaching the root of the tooth. The term 'dens in dente' is given to a severe invagination that gives the appearance of a tooth within a tooth. In a radiograph this condition is seen as a 'pear shaped' radiolucency in enamel and dentin with a narrow constriction at the opening on the surface.

Supernumerary teeth or hyperdontia

This refers to a condition where extra teeth than normal are present. Supernumerary tooth develop from an additional dental lamina near the permanent tooth bud or by splitting of the permanent tooth bud itself. When the supernumerary teeth are located in the dental arch, assisting the normal teeth in function they are called supplementary teeth.

The most common supernumerary tooth is 'mesiodens' (Fig. 21.6). Mesiodens is an extra tooth located between the two maxillary central incisors. This is a small conical tooth with a small root. Mesiodens may occur singly or paired, erupted or unerupted. This tooth can cause esthetic problems.

Distomolar is the second most common supernumerary tooth. They are situated distal to the third molar and may be smaller or of the same size.

Paramolars are the supernumerary teeth present either buccal or palatal to the molars. This may be single or multiple and smaller or of the normal size.

Multiple supernumerary teeth are present in 'Gardner's syndrome' and 'Cleidocranial dysplasia'.

Anodontia or hypodontia

This refers to absence of all or some teeth. True anodontia is congenital absence of teeth which may be total or partial. In total anodontia all the teeth are missing and is usually a feature of hereditary ectodermal dysplasia. The term partial anodontia is used when one or more teeth are missing. Most commonly missing tooth is third molars followed by maxillary laterals and second premolars. The condition in which multiple teeth are impacted is referred to as pseudoanodontia. False or induced anodontia occurs as a result of extraction of all the teeth.

Supernumerary cusps or roots

Supernumerary root (Fig. 21.7) refers to a condition where a tooth has extra root than normally expected. This condition is seen mainly in mandibular canines and premolars. These extra roots can cause difficulties in extraction and an unrecognized broken root that is not removed may cause infection

Any extra cusp on a tooth is called as supernumerary cusp. Rarely this may interfere with occlusion.

Enameloma (Enamel pearl) (Fig. 21.8)

Enamel pearl is a globule of enamel seen on the root near cemento enamel junction or close to

furcation area. These structure may have a central core of pulp covered by dentin and enamel. Enamel pearl is formed by a group of displaced ameloblasts or cells of Hertwig's epithelial root sheath that have attained a capacity to form enamel.

Microdontia and Macrodontia

Microdontia is a condition wherein the teeth are smaller than normal. This condition may be true or relative. In true microdontia the actual size of the tooth is small. In relative microdontia the actual size is within normal range but appears smaller because of larger jaws. Generalized microdontia is seen in pituitary dwarfism. Peg

shaped lateral incisor is the most common single tooth that appear as microdont.

Macrodontia is a condition in which teeth are larger than normal. This also may be true or relative. In true macrodontia the actual size of the tooth is large. In relative microdontia the actual size is within normal range but appears larger because of smaller jaws. Generalized microdontia is seen in pituitary gigantism. In hemifacial hypertrophy the teeth on the affected side may be larger than normal.

The term Rhizomicry (Fig. 21.9) is used when the roots are smaller than normal. Rhizomegaly (Fig. 21.10) refers to abnormally larger roots.



Fig. 21.2 Fusion



Fig. 21.3 Concrescence



Fig. 21.4 Dilaceration

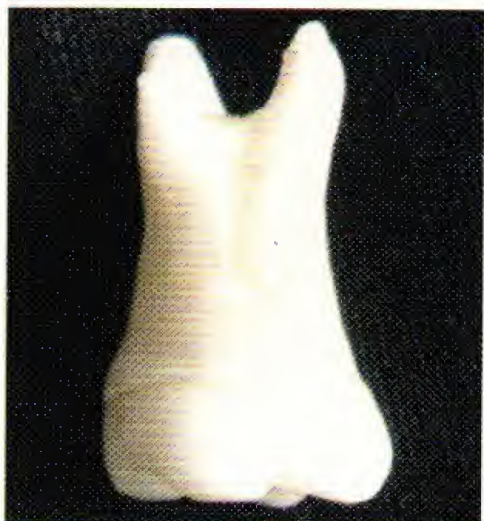


Fig. 21.5 Taurodontism



Fig. 21.6 Mesiodens



Fig. 21.7 Supernumerary root



Fig. 21.8 Enameloma



Fig. 21.9 Rhizomicry



Fig. 21.10 Rhizomegaly

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Dr. Maji Jose is an Oral Pathologist currently working as Professor in the Dept. of Oral Pathology, Yenepoya Dental College, Mangalore. After obtaining B.D.S. & M.D.S. in Oral Pathology from College of Dental Surgery, a constituent institution of Manipal Academy of Higher Education (MAHE Manipal) she worked in the same institute for seven years. She has also worked in K.V.G Dental College, Sullia for couple of years. The author has more than a decade of experience in teaching Oral Histology and Oral Pathology. She has many publications to her credit.



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